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WAS EVOLUTION INVENTED BY GREEK PHILOSOPHERS?

THE GENETIC HISTORY OF THE ISRAELITES

THE SATELLITES OF PLUTO

IS THE FIFTH TOE VESTIGIAL?

MAKING SENSE OF BABEL AND AFTERWARDS

JOURNAL OF CREATION

An international journal devoted to the presentation and discussion of technical aspects of the sciences such as geology, biology, astronomy, etc., and also geography, archaeology, biblical history, philosophy, etc., as they relate to the study of biblical creation and Noah's Flood.

COVER: Tower of Babel

IMAGE: 123rf.com/Elena Schweitzer

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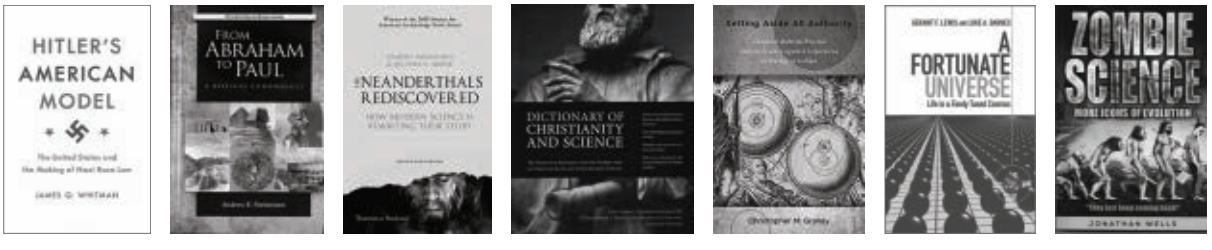

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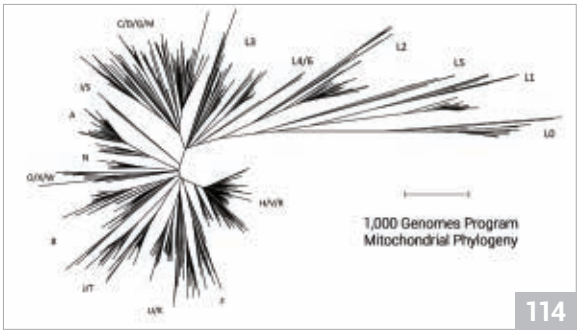

Should the Jewish nation, as a Middle Eastern tribal community, have Middle Eastern genetic roots?

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Planation surfaces below the Antarctic Ice Sheet

Michael J. Oard

All continents display large, flat erosional surfaces called planation surfaces. Indeed, planation surfaces are especially widespread on the continents of Africa and Australia. The prevalence of the water-rounded rocks that commonly cap their surfaces suggest these surfaces were formed by a heavy sediment-filled flow of water. Antarctica is no exception to planation features. Nunataks are mountains that stick up above the ice and planation surfaces have been carved on some of these mountains.[1,2]

Now found below Antarctic ice

An airborne geophysical survey was undertaken across the Institute and Möller ice streams, which drain 20% of the West Antarctic Ice Sheet.[3] The ice streams drain into the Filchner-Ronne Ice Shelf marine embayment and are grounded below sea level. Researchers discovered that in the bedrock below the ice, there is a zone of apparently flat and smooth topography between the deeper troughs and basins occupied by the two fast ice streams (figure 1). The smooth topography between ice streams is heavily dissected by U-shaped valleys and is composed of a higher surface and a lower surface, separated by a break in slope, as seen in the longitudinal cross-section (figure 1c). It is probably just one large roughly rectangular planation surface at two different altitudes, covering an area of about 30,000 km^2.

The area is covered by 1–2 km of ice. The bedrock below is folded sedimentary rock with granite intrusions that stick above the ice as nunataks, meaning the planation surface often cuts at an angle to the bedding. The present altitudes of the planation surface range from 200 m to –1,500 m, which if corrected for isostatic depression caused by the ice would have been 600 m to –1,100 m. The mean elevation before glaciation would have been 270 m below sea level. The researchers correctly interpreted the surfaces as pre-glacial.

Planation surfaces have also been discovered below the ice in other areas of Antarctica. The current planation surface under discussion was likely much larger:

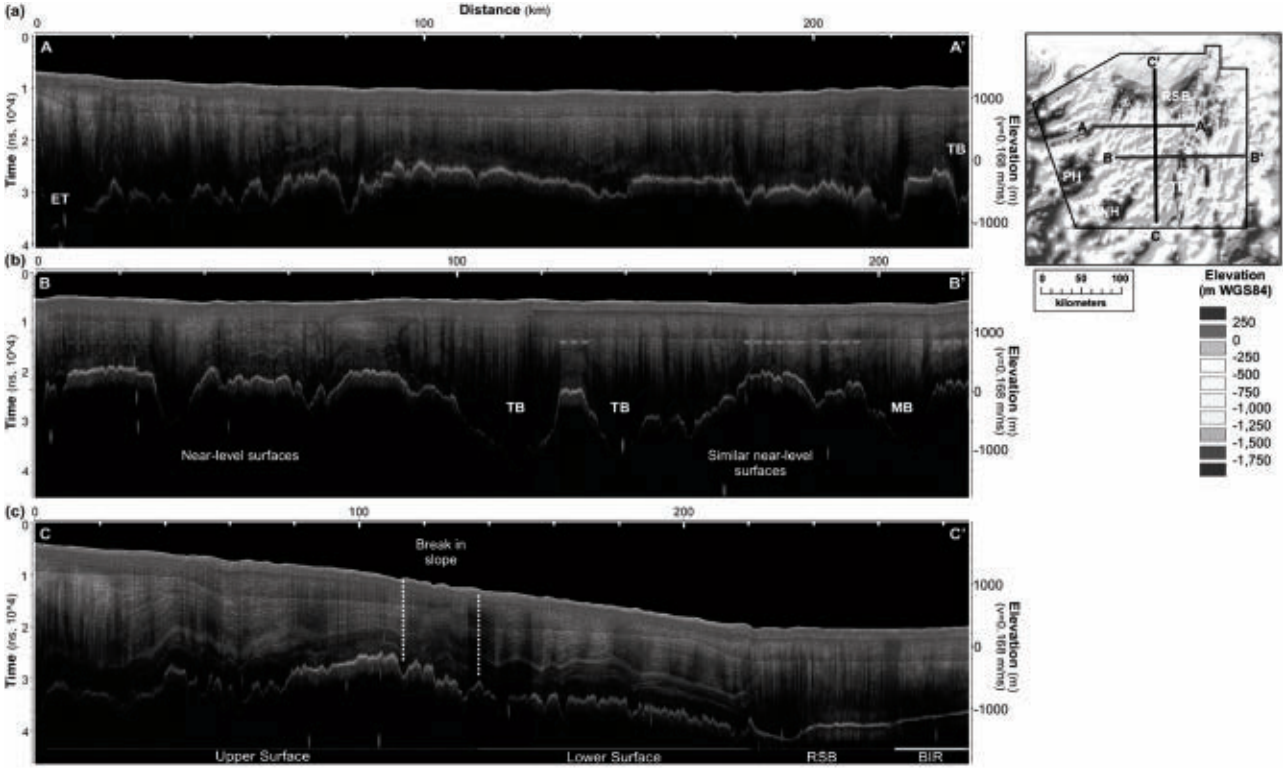

Figure 1. Radar echograms showing the dissected planation surfaces.[3] A–A′ and B–B′ are transects perpendicular to the ice stream flow and C–C′ is a transect parallel to flow, which is left to right. Exact locations of profiles are shown in the upper right. Notice also that the isochronous, volcanic layers in the ice form waves that are generally vertical with the bottom topography. Is this pattern an indication of little ice movement and youthfulness of the Antarctic Ice Sheet?[7,8]

> "Radar echograms, for example, hint at the existence of a more laterally continuous erosion surface extending across the Transitional and Marginal Basins … . As a result, only remnants of this surface, between basins, have remained."[4]

The researchers were puzzled about the origin of such a planation surface. They acknowledged the uncertainty and long debates over the origin of such surfaces. They have two favoured hypotheses: marine erosion or fluvial (river) erosion.

Marine erosion along the coasts of many previously glaciated areas does exist, e.g. along almost all the west coast of Norway. They are called strandflats, but their origin is also a mystery,[5] although marine abrasion is suggested. The problem with using strandflats as an analogue to the planation surface under discussion is that strandflats are only several tens of kilometres wide at most.[6] Moreover, strandflats are near the present sea level. Within the biblical framework, this is best explained by sea ice erosion during the Ice Age, particularly during deglaciation.

The researchers believe that river erosion could have formed planation surfaces. This seems to be the default explanation for planation surfaces worldwide. However, no one has observed the formation of a planation surface except on a very small scale. The only exception is when a river floods and planes its bank, but this is a very local occurrence compared to planation surfaces that are commonly tens of thousands of km^2 in area. The problem with the example under study is that the planing occurred at an average of 270 m *below* sea level. So, the researchers suggest that the area could have been tectonically higher in the past.

Planation surfaces indeed worldwide

The planation surfaces that are observed below the ice in Antarctica are similar to some of those found on other continents, and it could be argued that their formation is of similar origin. Sheet flow during the runoff of the Flood would have flattened the surface and deposited rounded rocks. This would have been followed by channelized erosion. The final phase of the Flood was at a time of differential vertical tectonics that would have broken up and/or eroded large planation surfaces, sometimes down into erosional remnants.

Antarctica is not an exception to the puzzling (for those who hold to uniformitarianism) geomorphological features seen on other continents. The valleys carved into the planation surface are thought to be glacial, but they could easily have been carved by channelized erosion and later modified by ice.

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The satellites of Pluto

Wayne Spencer

In recent issues of *Journal of Creation*, John Hartnett and Danny Faulkner have both commented on discoveries regarding the satellites of Pluto from the July 2015 New Horizons mission.[1,2] There are many mysteries about the Pluto system that are sure to be the subject of much research and discussion for years to come. Hartnett and Faulkner addressed some difficulties for evolutionary naturalistic theories to explain the origin of Pluto's natural satellites. I would like to comment on the new theories being explored by planetary scientists regarding the Pluto system.

The New Horizons mission to Pluto has provided much new information that challenges planetary scientists.[3] More information may be coming in 2019 since plans are underway to conduct another flyby of a trans-Neptunian object (TNO) called 2014 MU_{69} with the New Horizons spacecraft.[4] (Trans-Neptunian objects are also known by the older term, Kuiper belt object.) The New Horizons mission has established definitive values for the densities of Pluto (1854 ± 6 kg m^{-3}) and Charon (1702 ± 17 kg m^{-3}).[5] From this and other data the implication is that Pluto is approximately 65% rock by mass while Charon is about 59% rock. Both Pluto and Charon are likely to have some ice in the interior and they may have thick ice layers from the surface to some depth or under a crust. There is debate as to whether Pluto could have a liquid layer. Questions about Pluto's interior cannot be fully answered from the New Horizons data because the gravity data is not sufficient. Gravity data is of limited usefulness in the case of New Horizons since it was a very rapid flyby. An orbiter would be needed to get better gravity data and thereby determine

Figure 1. Pluto's small satellites. The four small satellites are shown to approximately the same scale, and they range in size from approximately 10 to 40 km. Processed images are from the Long Range Reconnaissance Imager (LORRI) on the New Horizons spacecraft in 2015. (NASA/Johns Hopkins University Applied Physics Laboratory/Southwest Research Institute).

more about Pluto's interior. Both Pluto and Charon have interesting geological features on the surface and Pluto has many interesting atmospheric phenomena as well.

The origin of Pluto has always been challenging from the point of view of naturalistic assumptions. The New Horizons spacecraft reached Pluto at a time in which there has been a revolution in solar system origins theories with the application of planet migration theory to the origin of the outer planets. The model that involves the migration of Uranus and Neptune is known as the Nice Model.[6,7] The Nice Model proposes that the four outer planets—Jupiter, Saturn, Uranus, and Neptune—formed closer to each other and closer to the Sun than in their present orbits and then migrated outward. This outward migration involved orbital resonances between Jupiter and Saturn, and between Saturn, Uranus, and Neptune. The Nice Model also assumes that the region from approximately 20 to 30 AU from the Sun once was filled with a disk of planetesimals far more massive than those of today's trans-Neptunian region. The trans-Neptunian region today has only approximately one tenth of an Earth mass of material.[8] But in the Nice Model this region is assumed to have included a large population of objects totalling approximately 35 Earth masses.[9] The migration of Neptune into this outer planetesimal disk is thought to have caused an 'instability' that scattered most of the planetesimals. This instability scattered planetesimals in all directions and caused many impacts and other interactions of objects. Some argue that this instability caused the Late Heavy Impact bombardment on the moon. However the timing of this instability is debated and so some would argue it had nothing to do with the Late Heavy Bombardment of impacts in the inner solar system. This migration of Neptune and the planetesimal scattering event has gained much acceptance in the scientific community today. This puts the origin of Pluto in a different context than in past theories.

In recent years, leading up to the New Horizons spacecraft's arrival at Pluto, a theory was developed that Pluto's large satellite Charon formed from a large impact with Pluto.[10] This impact formation concept is very similar to the proposed origin of Earth's moon via a large impact.[11] It is thought that Pluto and Charon are similar enough to each other in composition (with some rock and some ice) that a large impact could form a debris disk around Pluto that could coalesce into Charon. Then after Charon formed, it is thought there would be a period where Charon would migrate outward away from Pluto due to tidal effects until it reaches a point where it would be in synchronous rotation with Pluto. This is Charon's current orbital state. It has one side facing Pluto at all times and the time for one spin on its axis matches the time for one orbital revolution about Pluto. It is not surprising that Charon would be in this configuration since it is stable this way.

The small satellites

Pluto's small satellites—Styx, Nix, Kerberos, and Hydra (figure 1)—complicate and challenge the above scenario. First, the small satellites are much icier and have significantly less rock than Pluto and Charon.[12,13] Though their density is not yet well

known, it seems they are icier than Charon and may be icier than many TNOs. It has been estimated that all four of the small satellites have geometric albedos greater than 50% and that the albedo of Hydra may be near 85%.[13] They are in nearly circular orbits and their orbits are very nearly in the same plane. If a satellite has a circular orbit and its orbit inclination is close to the same plane as the equator of the parent object, then it is normally considered 'regular' and it is assumed to have formed with the parent object. However, this is not likely for Pluto's small satellites by known physical processes, since they are of a different composition than Pluto and Charon. Planetary scientists may take the view that the current set of small satellites is not the original set that would have formed with Pluto and Charon, but this makes an assumption on the history of the Pluto system that may not be valid. Scientists have investigated scenarios in which the small satellites would migrate outward as Charon migrates outward. It was thought there could have been multiple orbital resonances at work between Charon and the small satellites that would move the small satellites into their current orbits. Also, it was assumed that interactions of the small satellites with Charon could explain the rotation behaviour of the small satellites. However this is not bearing out as planetary scientists have worked on computer models.

Pluto's four small satellites are currently following nearly circular and coplanar orbits which are in resonances with Charon (Styx 3:1, Nix 4:1, Kerberos 5:1, and Hydra 6:1 (figure 2)). A study of the origin of Pluto's small satellites in connection to an impact origin of Charon was published in 2014.[14] The concept explored was that as Charon migrated outward due to tidal effects, the small satellites could accrete from material left over from the large impact. Then the small satellites could migrate outward in multiple simultaneous resonances, migrating together. Simulations were attempted of this scenario. Some resonant migration occurred in some cases, but not for all four satellites simultaneously. Even if some of the satellites migrated to the proper orbital distances their orbits were significantly more eccentric than they are found today. If these small bodies' orbits became too eccentric or they migrated to distances somewhat different, it tended to make their orbits unstable. It was concluded that it was unlikely for Styx, Nix, Kerberos, and Hydra to all migrate to their current orbits in this way. The authors of the 2014 study, Cheng, *et al.*, make this statement: "We conclude that the placing of the small satellites at their current orbital positions by resonant transport is extremely unlikely."[15]

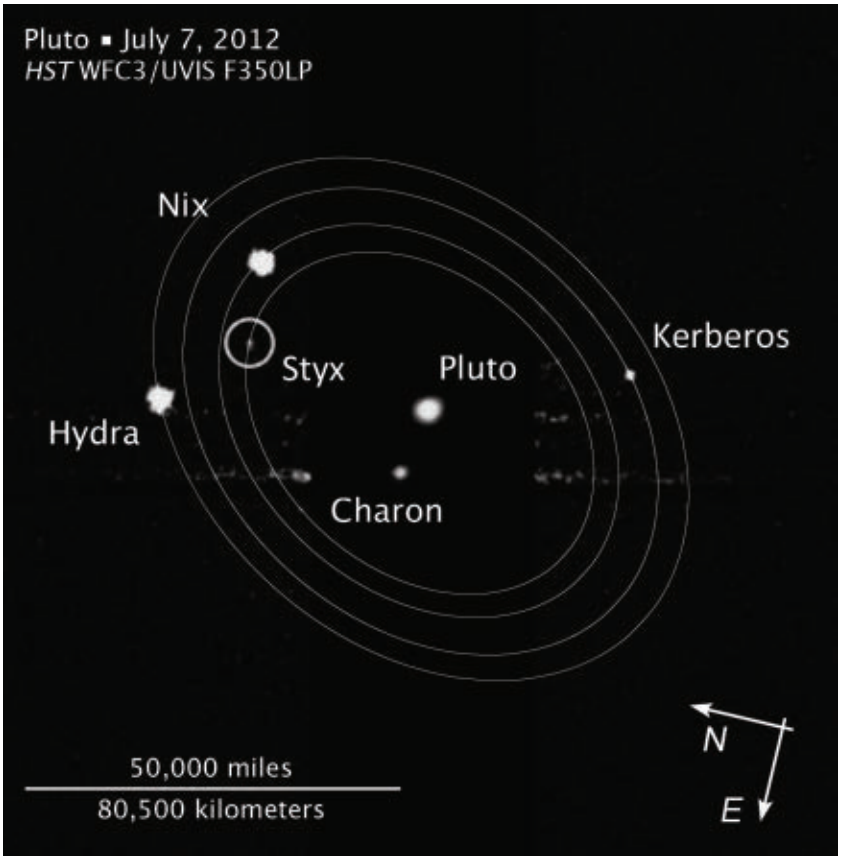

Figure 2. Pluto, and its satellites with their orbits. Image from the Hubble's Wide Field Camera 3 from July 2012. (NASA, ESA, and the Space Telescope Science Institute).

Faulkner also commented that it is unlikely the four small satellites were captured, as suggested by Hartnett. I concur with this since captured objects would have highly eccentric orbits and would not be in the same plane, unless perhaps they were once part of one object that was disrupted. Hydra is in the outermost orbit and is spinning extremely rapidly, as Hartnett points out. This is challenging to explain unless it is simply there from creation. A collision might spin up an object but it would also make the orbit more eccentric. Planetary scientists will take the view that Hydra is a composite of multiple planetesimals that collided and joined into one body. But again, this kind of collision would not be likely to leave the orbit nearly circular. In my opinion, Hydra's high rotation rate in combination with its circular orbit is not easy to explain from any collision scenario.

In addition to the above, the origin of the four small satellites is even more

puzzling in light of the Nice Model for the origin of the outer solar system. In the Nice Model, Pluto would have begun as one of many other large planetesimals in the region between approximately 20 and 30 AU in the early solar system before Neptune migrated outward to its current orbit. In current theories, planet migration facilitates objects coming into orbital resonances. Thus, Neptune and Uranus migrated outward in the Nice Model and this migration is believed to explain how Pluto could come to be in the unique 3:2 orbit resonance that it has with Neptune. But as Neptune migrated outward in the Nice Model, Pluto and Charon, as well as the four small satellites, would have to survive the migration and migrate with Neptune. It is thought Pluto and Charon had to form early, before Neptune's migration, because the large collision forming Charon requires an extremely low relative velocity between the impactor striking Pluto and Pluto itself.[16] This low velocity would seem to only be possible early in the solar system, not later as Neptune is migrating or after Neptune excited the instability that scattered planetesimals in the outer solar system. Although computer simulations do show that some satellites can stay in orbit around a migrating planet, their orbits are altered. It is often just assumed that after their orbits are altered they would stabilize and eventually circularize. But it is not at all clear this would work. Also, the Nice migration scenario requires millions of years, which conflicts with a young-age timescale.

The rotation rates of the small satellites of Pluto require more research and better data. There is a need to have better photos of Styx, Nix, Kerberos, and Hydra. There is also a need to know their sizes and densities to more precision. The high spin rate of Hydra is so fast that the other small satellites and even Charon would have little effect on it. Small collisions could help explain the spins of Styx, Nix, and Kerberos, but Hydra requires a different explanation. Another significant fact is that the New Horizons spacecraft did not discover any additional new small satellites of Pluto during the flyby. This was surprising to planetary scientists. If the four small satellites formed in a collision event, it seems likely more small objects would have been found. Therefore, whether the small satellites originated early at the time Charon formed or they were captured later, there are serious problems with explaining their origin. If they formed early along with Charon, why would their composition be so different than Charon and different from other Kuiper Belt objects? Currently planetary scientists seem to have no workable theory for the naturalistic origin of the four small satellites of Pluto.

Conclusions

A creation perspective is likely to find support from the Pluto system from the difficulties with naturalistic models. However, I would recommend that creationists should avoid drawing too many conclusions too early, especially regarding young-age arguments. Creationists should watch the ongoing research on the Pluto system. The small satellites of Pluto are in a complex dynamic relationship with Charon and Pluto. Computer simulations of satellites of Pluto show that many orbit configurations are unstable or do not end up as circular, like we find the orbits today. The unusual spins of the small satellites of Pluto may never reach a 'tidal lock' configuration due to the unique influence of Charon and the way the small satellites influence each other. Hydra's extremely rapid spin is mysterious. I have found it most fruitful to assume that most characteristics of things in the solar system stem from how they were created in the Creation Week, several thousand years ago. In a young-age timescale many processes assumed to have operated for millions of years by secular scientists have not had time to make significant change. Long periods of time and natural processes do not solve scientific mysteries. But, not every feature goes back to creation. Catastrophic and chaotic events are possible in the solar system. But our solar system exhibits both intelligently designed order and surprising creative features that point to a powerful Creator.

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Planation surfaces formed by river piracy?

Michael J. Oard

The idea of river piracy is that the tributary of a river erodes through a headwater barrier and captures the water from another river or stream (figure 1). As a result, the water increases in the pirating stream and decreases at the downstream end of the captured river. By this process, river piracy or capture is considered one of the main uniformitarian explanations for how a water gap (a deep pass through a mountain, mountain range, plateau, or any other transverse barrier) can be formed.[1–3]

However, despite the presence of thousands of water gaps across the earth's surface there is no concrete evidence that this is an adequate explanation. More surprising, though, is the recent argument that water gaps, apparently derived from river piracy, are also responsible for explaining regional scale planation surfaces. The concept that low-relief landscapes can be formed by river piracy and river network disruptions such as water gaps, put forward in a recent paper, is strongly challenged here.

Observation of river piracy

River piracy has been *inferred* from relief (topography). It has never been observed—until recently.[1,2] The Slims River in the Yukon Territory of Canada flows north and the Kaskawulsh River flows south-east from a very low divide occupied by the outlet of a valley glacier. The snout of the glacier receded back due to what some claim to be recent global warming.[3] In May 2016, the Kaskawulsh River captured the Slims River. It appears that before the Little Ice Age, the water of the Slims River had flowed south into Kaskawulsh River, like it does today. But when the glacier advanced during the Little Ice Age in the 1700s and 1800s, an outwash fan separated the river, allowing the two branches to flow north and south until May 2016. The authors of the original report stated their accomplishment:

> "Furthermore, previous studies of river piracy have dealt with capture over Quaternary or longer timescales, with no one, to our knowledge, having detailed the phenomenon in the modern era."[4]

Although this is the first observation of river piracy, it is a trivial example, especially when river piracy is invoked to account for gorges that transverse barriers hundreds of metres high.

River piracy claimed to cause planation surfaces on south-east Tibetan Plateau

Planation surfaces[5] are common geomorphological landforms found at all elevations all over the earth. They are generally flat surfaces eroded in hard rock with a veneer of mostly rounded rocks capping the surface. The most distinctive planation surfaces are found at the tops of mountains. These are the most challenging for uniformitarian scientists to explain.[6] It is all the more difficult since many active mountains of the world have mountaintop planation surfaces: "Low-relief erosional surfaces have been described in nearly every active orogeny [mountain range]."[7]

For example, the Tibetan Plateau is a 2.5 million km^2 dissected planation surface about 4,500–5,000 m above sea level. The dissected planation surface slopes south-east toward lower elevations.[8] The sloping surface is highly dissected by three rivers that form gorges 3–4 km deep.

The traditional view is that the Tibetan Plateau planation surface was carved near sea level, uplifted, and dissected. Yang *et al.* proposed a new, ingenious hypothesis based on river capture. To explain why planation surfaces lie between the rivers, Yang *et al*. assumed that the surfaces originally formed well above sea level, *in situ* with a little isostatic uplift.[9,10] They suggested that a tributary from one river captured the water from a second river. With decreased flow, the second river was unable to significantly erode its channel bed. Then, as the sides of the second river eroded more, the area occupied by the second river eroded into a nearly flat surface.

New hypothesis untenable

This new hypothesis for the formation of mountaintop planation surfaces at near their current elevation has numerous problems.[11,12] First, Yang *et al*. used only a simple model to verify their hypothesis, but the area is so complicated with three parallel, deep river gorges in close proximity separated by planation surfaces that it demands a more complex model. Even a complex model would not be able to account for the many variables and their nonlinear interactions, such as changing mountain relief due to erosion.

Second, Yang *et al*. need numerous expansions and contractions of river networks. It would take multiple tributary captures to flatten all the interfluves between the present-day modern rivers. Unfortunately for their proposal, it does not appear that significant rivers ever occupied the planation surfaces, yet it is claimed that the rivers originally carved the planation surface.[8]

Third, the planation surface should be at different elevations south-east of the Tibetan Plateau because the rivers would have had different volumes of flow and erosion potential, but instead are of similar elevation, sloping down in a south-east direction. The area generally looks like a huge single, dissected planation surface, as traditionally believed.

Fourth, the evidence for river capture is equivocal, since the

Figure 1. Block diagram of river capture (drawn by Peter Klevberg). Two streams are flowing parallel to each other, and the tributary of one stream erodes through the ridge between the streams and captures the water from the other stream.

suggested evidence can just as well be explained by the uniformitarian mechanism of an uplifted planation surface that is dissected.

Fifth, there may not have been enough time for the planation to occur while the catchment edge of the second river was aggressively incised by neighbouring rivers.

So, it looks as though the traditional explanation of the uplift of a planation surface is still the preferred view. Whipple and colleagues conclude:

> "… [this] demonstrates that the topography [of the south-eastern Tibetan Plateau] is in no way consistent with the drainage network dynamics mechanism and is fully consistent with incision into an elevated, pre-existing low-relief landscape."[13]

Discussion

Planation surfaces do not form today, except along the edge of flooding rivers.[14,15] Instead, they are dissected and destroyed. It is more likely the Tibetan Plateau planation surface was carved by a wide, fast-moving current of water consistent with the sheet flow runoff during the Recessive Stage of the Flood.[16] The fact that the planation surface was carved on variable rock types supports this conclusion.[8]

The planing and dissection of the Tibetan Plateau occurred during the Cenozoic. Clark *et al.* state:

> "The landscape of eastern Tibet is highly unusual; it stands at high elevation and is drained by four of the world's largest rivers, yet it has experienced little erosion in Cenozoic time … ."[17]

Presently, the river channels are rapidly eroding, but the erosion has not worked back to the upstream eastern Tibetan Plateau planation surface. The geomorphology of the Tibetan Plateau and the south-east sloping planation surface between rivers strongly suggests that the time for the Cenozoic is greatly exaggerated. This evidence further confirms that water gaps, supposedly derived from river piracy, were not the formative features of the planation surface.

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Hybridization shaking up the evolutionary Tree of Life—what does it mean for creationists?

Jean K. Lightner

In 2016 *Science* featured an article with the provocative title "Shaking up the Tree of Life", stating: "Species were once thought to keep to themselves. Now hybrids are turning up everywhere, challenging evolutionary theory."[1] Despite its sensationalized tone, this article brings up a number of valuable points. To understand their significance, we first need to look at some history behind our understanding of species and observations regarding hybridization.

Historical views: hybrids in plants

Carolus Linnaeus (1707–1778) is best known for formalizing modern taxonomy. Based on his work, scientists continue to identify organisms using binomial nomenclature, which includes the genus and species name. It has been said that initially Linnaeus viewed each species as a distinctly created kind. Yet in his 1759 *Generatio Ambigena* he suggests that the originally created species have diversified into what he recognized as families. Based largely on his experience with hybrids in plants, he suggested that hybridization was a mechanism by which new species could arise.[2]

William Herbert (1778–1847) was a British clergyman and botanist who studied plants in the family Amaryllidaceae (e.g. narcissus or daffodils). He was a contemporary of Charles Darwin and even wrote Darwin a letter discussing hybrids in plants.[3] In his 1837 publication *Amaryllidaceae*, Herbert made a number of profound arguments still used by creationists today.[4] For example, he recognized that hybridization, regardless of whether or not the offspring were fertile, provides evidence that the parents "were descended from one common stock"[5] (i.e. both from the same created kind).

Herbert recognized that the variation seen between different varieties in a single species of domestic plant was essentially the same as that seen in different species in the wild. He pointed out that if fertility of offspring was the criteria for the species designation, many plant species recognized at that time would disappear, as morphologically distinct species would be grouped together. He also provided specific examples demonstrating that obvious morphological differences can be a poor predictor of whether or not fertile offspring can be produced when hybridizing.[6]

Herbert further considered the impact of the Flood on plant life. He suggested God designed the original created kinds capable of making permanent variations under different circumstances, such as different soil or climate conditions. He suggested that diversification was probably early and rapid following the Flood. While most of his discussion is centred around plants, he does briefly discuss his ideas in relation to birds and dogs. For example, he did not believe that all species needed to be on the Ark, and, based on personal experience, he believed foxes and dogs were part of the same kind.[7]

Elizabeth Pennisi's *Science* article alludes to Edgar Anderson's 1949 book *Introgressive Hybridization* as presenting novel ideas about the role of hybridization in plants.[8] Indeed, his work is important and did challenge the views of his contemporaries. However, as is evident by this short discussion, the popular views among scientists of that era were at odds with evidence that had been presented by eminent creation scientists more than a century before.

Species definitions vs kinds

Today the most popular definition of species can be traced back to Mayr's "Biological Species Concept", which defines a species as reproductively isolated from all other species. Generally, this is not tested because it is difficult to do so in the wild. Instead, inferences are made about whether or not the population considered will interbreed with other species under natural circumstances. There are also a number of other factors that come into play when biologists define species.[9]

It is important to note that eminent creation scientists of the past did not believe that species were fixed entities. As mentioned above, by 1759 Linnaeus believed that the created progenitors (kinds) had diversified to form the families of organisms that he identified. Note that this was a full century before Darwin published his famous work! Herbert, a contemporary of Darwin, felt that the genus should correspond to the level of the kind. When hybrid offspring were produced between members of different genera, regardless of fertility, he felt they should be reclassified to the same genus.[10]

Herbert's suggestion that the genus should be at the level of the kind is consistent with his comment that when offspring are formed from a cross, it was reasonable to believe that "the parents were descended from one common stock". The word genus essentially means just that, stock, and appears in many translations of Genesis for the Hebrew word *min* (kind).[11] However, there are times when hundreds or even a thousand

Figure 1. A new species of finch developed on Daphne Island when a large immigrant male from a related species mated with a medium ground finch on the island. Within a few years the hybrid offspring only mated among themselves, forming a reproductively isolated population; a new species.

or more species are connected by hybrid data.[12] Given that taxonomy is intended to provide a valuable tool for organizing and understanding the life God created, this would make the genus an unwieldy category when used to lump animals into 'kinds'.

Erich Wasmann was a Jesuit and renowned entomologist who was born in Austria in 1859, the year Darwin published his famous work. In *Modern Biology and the Theory of Evolution*, Wasmann argued for the theory of evolution in contrast to the theory of permanence (i.e. species fixity).[13] Using his extensive knowledge of ants and termites, he pointed out that species fixity would imply progressive creation. This is because many similar insect species have very specific symbiotic relationships with other insect species. To explain the patterns he details, either God created the original progenitors with the ability to form new relationships, or throughout history God would have had to create new species similar to ones he created previously.[14]

Despite Wasmann's use of the word evolution, he very clearly believed in the doctrine of creation as presented in Genesis 1. Based on observational evidence, he argued that the primitive forms God created diversified relatively rapidly to form different genera and sometimes families.[15] He insisted the only way to account for his observations was for God to have created organisms with interior 'laws' to allow them to respond beneficially to exterior influences.[16] He doubted natural selection played much of a role, since it cannot create anything new, but only removes some of what is already present.[17]

One thing that confuses the issue is the fact that the many words can be used in more than one sense. The word *species* is sometimes used to translate the Hebrew word *min* (kind) in Genesis 1.[18] Additionally, Linnaeus said that we reckon as many species as there were different forms created at the beginning.[19] Wasmann attempts to reconcile this by introducing the idea of natural species (equivalent to the modern creationist idea of created kinds) and systematic (taxonomic) species.[20] Clearly, the words *genus* and *species*, when translations use them in Genesis 1, are not being used the same way as biologists use them for taxonomic purposes.

Evolutionary philosophy and the obscuring of science

Pennisi's article clearly shows how philosophy can become so entrenched that observational evidence is essentially ignored. She describes the influence of Mayr's views, and how despite knowledge of hybrids formed in zoos, the prevailing opinion among

zoologists was that hybridization rarely occurred in the wild, and when it did, the offspring would certainly be less fit.[21]

There are several probable reasons scientists might assume this. The first is that species are relatively stable, and it would seem hybridization would blur the boundaries more than they are already. As it turns out, hybridization is common between closely related species, but normally only a small percentage of the individuals are involved. Even more interesting, the long-term health of a species can depend on low levels of hybridization, since it brings in variety that may have been lost during times of adverse conditions (e.g. drought).[22] So the ability to hybridize after lineages have diversified appears to be part of God's provision so his creatures could survive and thrive on the earth He created for them (figure 1).[23]

A second reason a scientist might assume that hybridization is rare or harmful in the wild is related to evolutionary philosophy. Darwin pictured life as a branching 'tree'. If hybridization occurs to any significant extent, you will have branches fusing back together. Without the relatively rapid appearance of reproductive incompatibility, explaining the morphologic chasm at higher taxonomic levels becomes more problematic; there should be a plethora of intermediates. Further, some of these species are said to be separated by millions of years, and it would be surprising that reproductive compatibility could be retained for so long as species diverge.

Conclusions

There are several important conclusions we can draw from this. The first is to recognize that species fixity (in the taxonomic sense) was *not* the view expressed by eminent creation field biologists of the past, despite the fact that Darwin sets it up as the view he is opposing. Christians should not be lulled into thinking we should cling to Darwin's strawman, since species fixity is not supported by observational science. The word *species*, as used in biology, is a man-made classification, and difficult to define. In reality, it is the biblical worldview that helps explain why scientists struggle so much to define what is meant by a species, and why so many species concepts have been developed to classify ambiguous populations.

The first chapter of Genesis tells us that God created various kinds of plants and animals to reproduce and fill the earth, and so they have. Today different populations that descended from the same created kind differ from each other enough that they should logically have their own names (e.g. Arctic fox, red fox, grey fox, bat-eared fox). Clearly, if they are distinct enough for their own common name, we will also give them a unique scientific name. Yet, we know based on hybridization that foxes, wolves and coyotes (i.e. all species in the taxonomic family Canidae) are descendants from one created kind.[24]

Given the fact that we see this pattern of diversity today, and that it must have arisen within a few thousand years from a limited number of ancestors (two for most animals on the Ark), it should be clear that God designed his creatures with this ability to diversify, as Wasmann pointed out more than a century ago. This implies that the species we see today are not static; they can still change on timescales we can observe if conditions are right.[25] This means there will *always* be ambiguity in our understanding of species, since it is not a created division. Taxonomically defined species are not equivalent to the kinds mentioned in the Bible, and it is unrealistic to expect them to be constant as we would expect kinds to be.

Another conclusion we can draw is that much of the excellent work of creation field biologists in the past was ignored as evolutionary philosophy took hold of Western culture. This danger, of powerful narratives obscuring reality, should be a warning to us all. We should be able to question why we believe what we believe. We should investigate empirical evidence looking for patterns, and noticing if it supports or contradicts our beliefs. We need Christian young people to rise to the challenge of exploring biology from a biblical perspective to enable us to better understand how God designed His creatures to diversify and adapt so they could fill the earth (Isaiah 45:18).

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At least some 'tillites' may be impact debris

Michael J. Oard

Uniformitarian earth scientists have presented creation scientists with many challenges. Each challenge must be addressed in detail before it becomes clear that the particular features claimed as proof of 'millions/billions of years' are no such thing. Often, such investigation also ends up challenging uniformitarian ideas. Indeed, creation scientists often find a reasonable solution, one that fits better in the Creation/Flood model than uniformitarianism, even given our limited manpower and funds.[1] An example of one such claim is that ancient ice age deposits, called 'tillites', prove the necessity for millions of years.[2,3]

The challenge of tillites

Tillites are defined as a consolidated glacial till; a mixture of rocks of all sizes within a finer-grained matrix deposited by glacial ice. Processes apart from glacial ice can produce till-like rocks. If the origin of the till-like debris is uncertain it is called a diamicton when it is loose and unconsolidated and a diamictite when it is lithified (transformed into stone). Tillites by this definition are rather numerous.

Besides a texture of rocks of all sizes within a finer-grained matrix, other glacial-like features are sometimes associated with tillites. They include:

- striated and grooved bedrock,
- striated, faceted, and/or polished rocks, and
- outsized rocks[4] within finer-grained sedimentary rocks.

Table 1. The four main ice age periods within the geological column[5]

Geological Period	Secular Age (Ma)
Late Paleozoic	338–256
late Ordovician	445–429
late Proterozoic	950–520
early Proterozoic	2400–2200

These features are considered 'diagnostic' of glaciation, since they are commonly associated with the 'Pleistocene' ice ages (the post-Flood Ice Age).

Other more minor features are also claimed as diagnostic, such as nailhead striations, which are striations or grooves that start abruptly on a bedding plan. Nailhead striations are thought to have formed when a rock in a moving glacier sinks down to the base and scratches the substrate. Combined with the features commonly regarded as diagnostic of glaciation, these give the impression of overwhelming evidence for tillites formed by multiple ice ages through geological history. These ancient ice ages, all before the 'Pleistocene' ice age are mostly fitted into four main time periods (table 1).

The challenge of ancient tillites for creationist geology is that widespread glaciations are not plausible to have occurred during Noah's Flood, when most of the rocks would have formed in that paradigm.

Responses to the problem of tillites

However, several responses to the challenge of tillites are possible, all centred on the conclusion that the tillites were not formed by glacial ice. First, numerous problems with the glacial interpretation have been revealed by both secular scientists[6] and creation scientists.[2,7,8] For instance, landslides either on land or on the ocean bottom can duplicate the till-like texture of the debris, and the three main diagnostic features.[2] An Eocene

Figure 1. Striated pavement from a landslide, now left as a remnant on top of the Gravelly Mountains, Southwest Montana, USA

debris flow exists now as a remnant on top of the Gravelly Mountains of Southwest Montana, USA. This debris flow duplicates two of the three supposedly diagnostic features of glaciation: striated bedrock (figure 1) and striated stones. Since the Eocene is considered by secular scientists to have been very warm, this debris flow, once thought to have been caused by a glacier, is now claimed to be from a non-glacial landslide.

Interestingly, the tillites are predominantly from low paleolatitude and marine deposits.[9] Because of this discovery, some of the Precambrian 'ice ages' are deduced to have been *global*. This is called the snowball or slushball Earth, and has enough problems for it to be deemed impossible by many.[10]

Moreover, creationists have offered non-glacial interpretations of tillite-like deposits. For instance, creationists have proposed that gigantic landsliding during the Flood can explain tillite-like deposits. Flood landslides can account for the large scale of some of the tillites, like the Dwyka tillite that occupies the bottom of the Karoo Basin, southern Africa, over an area about 1,300 km by 600 km.[2] It can also explain why practically all tillites are considered to be *marine* mass flows. Landsliding would have been a common occurrence during the Flood, considering the rapid accumulation of sediments and the magnitude of the tectonics.

Tillites from impacts

However, the above possibilities that have been offered by creationists are not exhaustive. Another that is worth considering as we investigate diamicton and diamictite formations in the field is that some may have formed from meteorite or comet impacts. This idea had been put forward by some researchers in the 1990s,[11,12] but the idea was strongly challenged by others.[13–15]

In a recent article,[16] Rampino points out again that all the major diagnostic features can be *duplicated* by non-glacial processes, especially when they are found at geological times when the climate was supposedly universally warm, such as the Mesozoic era, within the evolutionary timescale.

Rampino emphasizes that even the 'best' diagnostic criterion, outsized rocks within fine-grained sediment, can be duplicated by various types of mass flows, ranging from debris flows to turbidity currents. Nailhead grooves can also be produced by mass flow.

Moreover, in his recent article Rampino continues to suggest that some of these tillites could be impact debris.[16] In his view, given the millions of years of evolution, there should be more impact debris found in the rocks. He adds that striated and grooved bedrock and nailhead striations are rarely found below the claimed tillites. Interestingly, they are found associated with some impact debris, such as the Bunte breccia from the Reis impact in Germany.[17]

Although Rampino previously challenged the origin of most tillites,[12] in Rampino's latest article he narrowed his focus to the late Precambrian tillites, suggesting they may be impact debris. This could be due to a more comprehensive examination of the rocks in the most famous late Paleozoic 'tillite', the Dwyka tillite in southern Africa, in which no shock effects were found.[13] Moreover, shock features are lacking with other tillites, creating a significant difficulty for Rampino's suggestion of impact genesis. It is possible the field workers may have failed to look for them. Rampino points out that shocked rocks are also rare in known impact debris, and hence shocked rocks are a poor diagnostic criterion for impacts. He earlier claimed that shocked quartz was found in a rock from a late Precambrian tillite from southern Utah, but critics explained it away as possibly eroded from an older impact deposit, which seems unlikely.

Rampino also suggests a new impact-diagnostic feature, rocks showing brittle failure, and points out that these have been found in the Precambrian during 'non-glacial intervals'. He concludes:

> "The recognition that a number of diamictites in the geological record interpreted as tillites have a subaqueous debris-flow origin and the fact that some features ascribed to glaciation may not be entirely diagnostic suggests that a reinterpretation of some supposedly glacial tillites as non-glacial debris-flow/debris-fall deposits may be necessary."[18]

Conclusion

Mechanisms other than glacial ice have been found to produce tillite-like features. These include landsliding and impacts, and provide a viable explanation for how some ancient tillites were formed, one that fits within the Flood paradigm. It is not unusual for young earth researchers to discover alternative explanations for 'old earth' features within the uniformitarian literature itself. Creation scientists should continue to read all we can on a particular challenge. It is also important that we continue to undertake our own field work in case secular scientists missed what they did not expect to find. Answering challenges takes time, patience, and faith. We should not expect to answer all challenges to the Flood model since earth science itself is a developing field. This is attested by the tens of thousands of earth scientists worldwide doing research on unknowns and unsolved problems within their model. Creation science is only starting to develop a sophisticated Flood model and exciting discoveries remain to be made.

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Evidence for Flood fountains adjacent to the cratonic margin of southwestern Australia

Harry Dickens

Numerous articles in the creation literature refer to the fountains of the great deep that burst forth in Noah's Flood. However, this paper uses isotopic, petrographic, and geophysical data as evidence for Flood fountains near today's Darling Fault in southwestern Australia in the context of a new proposed model of the early Flood.[1]

Geological setting

Key tectonic elements in southwestern Australia include the Yilgarn Craton, the Albany-Fraser Orogen, the Leeuwin Complex and the Perth Basin (figure 1).

The Archean Yilgarn Craton consists of granitoids, greenstones, and high-grade gneiss belts. It is bounded on its western margin by the Darling Fault. Along the southwestern margin of the Yilgarn Craton, an escarpment (the Darling Range) separates the extensive plateau of the craton from the coastal plain. The scarp's location closely parallels that of the Darling Fault, which separates the Precambrian rocks to the east from the Phanerozoic sediments of the Perth Basin to the west.

The Mesoproterozoic Albany-Fraser Orogen is located along the southern and southeastern margin of the Yilgarn Craton. It consists of high-grade gneisses and granitoid intrusions.[2]

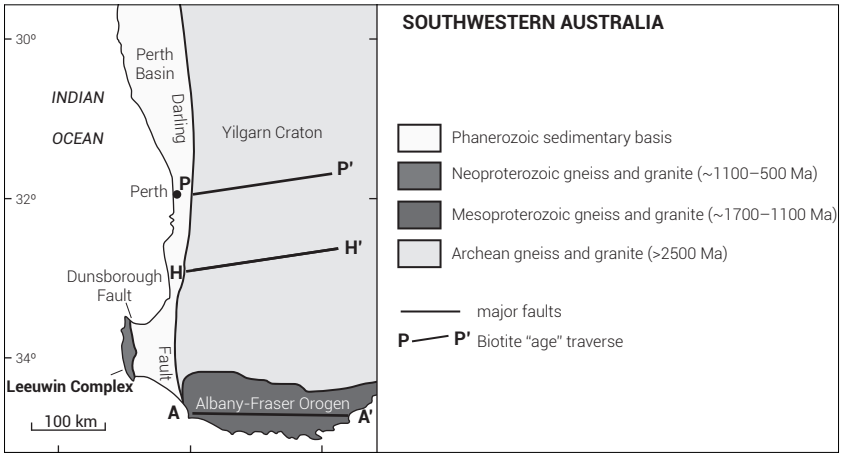

Figure 1. Map showing key tectonic elements of southwestern Australia (after Janssen *et al.*[11]) and approximate location of biotite 'age' traverses of Libby and De Laeter,[5] shown in figure 2

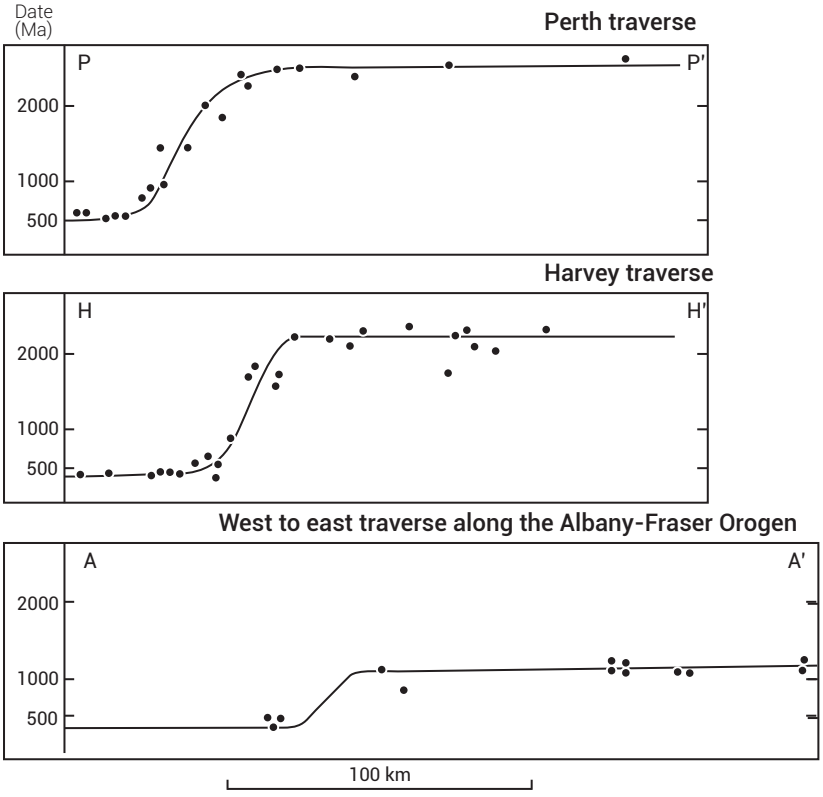

Figure 2. Biotite Rb-Sr radiometric 'age' versus distance sections extending eastward from the Darling Fault (after Libby and De Laeter[5])

The Neoproterozoic Leeuwin Complex is situated in the far southwest of Western Australia. It is bounded to the east by the Dunsborough Fault and to the west by the Indian Ocean. The Leeuwin Complex is a small segment of sialic crust and essentially consists of granulite metamorphic facies felsic gneisses.[3] The Leeuwin Complex is considered part of the Pinjarra Orogen, which is the name proposed for Precambrian rocks west of the Darling Fault.[4]

The Darling Fault is a major geological boundary between the Yilgarn Craton in the east and the Perth Basin in the west. It can be recognised at the surface and by geophysical methods for some 1,000 km. Up to 15 km of Phanerozoic sedimentary rocks occur in the Perth Basin.[4]

Isotopic and petrographic data

Rb-Sr radiometric 'ages' of biotite can be reset at temperatures well below magmatic conditions and are well suited for studying the post-emplacement history of crystalline basement rocks.[5] Biotite is particularly useful because of its wide distribution and well-known closure temperature.[5] The Rb-Sr system is very sensitive to hydrothermal fluid alteration, as this enables the diffusion of Rb and Sr, and the preferential loss of Rb from biotite.[6] Thermal resetting of radiometric ages is described in greater detail in the literature.[7,8]

Libby and De Laeter showed that biotite dates vary systematically along a traverse east from Perth (the Perth traverse; figure 2).[9] The traverse was divided into three sections, each with a distinctive set of Rb-Sr biotite dates:

1. The western section (closest to the Darling Fault) was shown to have the youngest biotite dates.
2. The middle, transition zone, tending to become older toward the east.
3. The eastern section has the oldest 'ages' and which are very similar to biotite dates over much of the rest of the Yilgarn Craton.

A second traverse about 100 km to the south of Perth (the Harvey traverse, figure 2) established that the trend of younging Rb-Sr biotite dates westward towards the Darling Fault was regional, reproducible, and systematic. This second traverse also defined the trend of the break between biotite on the east, which had typical Yilgarn Craton ages, and biotite to the west, which had younger 'ages'. The regional trend was found not to be parallel to previously described tectonic lineaments, such as the Darling Fault.[10]

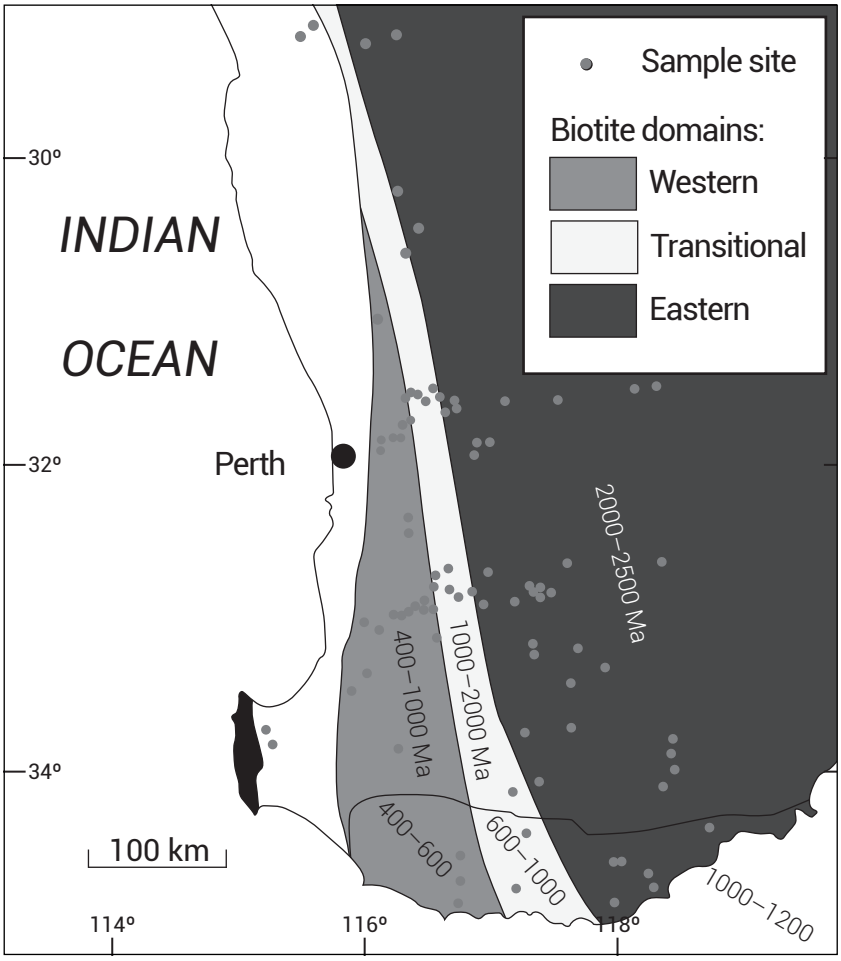

Figure 3. Map showing three biotite 'age' domains in southwestern Australia (after Janssen *et al.*[11])

To resolve the question of whether the regional trend extended further south, sampling was extended southward across the Albany-Fraser Orogen to the south coast and eastward beyond Albany. Rb-Sr biotite dates obtained along the Perth and Harvey traverses, and along the Albany-Fraser Orogen, were projected into cross-sections shown on figure 2.[5] Janssen *et al.*[11] produced an updated map of the three biotite 'age' domains—the western, transitional, and eastern biotite domains (figure 3).

Lu *et al.*[6] employed $^{40}Ar/^{39}Ar$ incremental heating experiments on muscovite and biotite grains from sample sites broadly comparable to those sampled by Libby and De Laeter's Perth traverse for Rb-Sr biotite analysis. Similar trends were obtained by $^{40}Ar/^{39}Ar$ biotite 'age' dating—oldest dates for the more interior Yilgarn Craton, with 'ages' decreasing abruptly to a narrow transitional zone, before decreasing further along the western margin of the craton.

In light of $^{40}Ar/^{39}Ar$ data in the western margin of both the Yilgarn Craton and the Albany-Fraser Orogen, young biotite 'ages' have been interpreted to result principally from hydrothermal fluid alteration.[12] Younger biotite $^{40}Ar/^{39}Ar$ 'ages' from the western margin of the craton are consistent with a late Neoproterozoic

tectonic event between Greater India and Australia (figure 4).[6,13] Moreover, paleomagnetic studies indicate that 'Greater India' was in a position adjacent to Western Australia in the late Neoproterozoic (figure 4).[13,14]

Petrographic observations indicate that most biotite grains in the transitional zone and western margin are severely chloritized and contain abundant titanite inclusions. These may have been caused by fluid-induced recrystallisation during an episodic hydrothermal and/or tectonic event.[6] Petrographic and chemical studies indicate that the biotite from each domain differs markedly in composition and origin, that is magmatic to the east versus hydrothermal to the west.[12]

The general northerly trend of late Proterozoic mafic dykes close to the Darling Fault[4] is consistent with an east–west extensional regime necessary for the development of the Leeuwin Complex.[2] These subvertical dykes are known as the Boyagin dyke swarm and increase in abundance towards the Darling Fault (figure 5). The Rb-Sr radiometric 'age' of 590–560 Ma together with the pattern and spatial distribution of these dykes in the southwestern part of the Yilgarn Craton suggests that the Boyagin dyke swarm is related to late Proterozoic orogenic activity.[4]

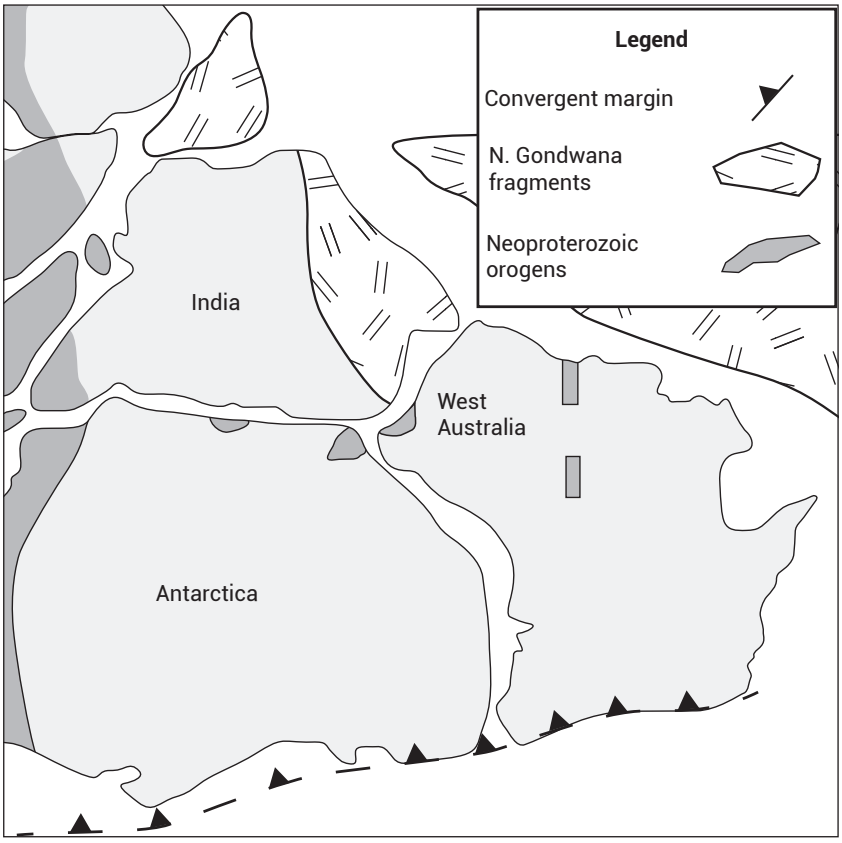

Figure 4. An inferred configuration of part of Gondwana around the time of the late Precambrian (Neoproterozoic) to Cambrian transition (after Kroner and Stern[13])

Geophysical data

Magnetotellurics is a passive geophysical method which uses natural time variations of the earth's magnetic and electric fields to measure the electrical conductivity of the subsurface. Depth information is obtained by measuring the time variations over a range of frequencies. High frequencies penetrate the earth to shallow depths only, while low frequencies penetrate deeper. Information is obtained from a few hundred metres depth to hundreds of kilometres depth.[15] Magnetotelluric data indicate a conductivity anomaly associated with the Darling Fault Zone, and this anomaly has been imaged as penetrating into the upper mantle.[16] Conductors have been imaged on other lithospheric fault zones around the world, being explained by fluids in the enhanced permeability of the damage zone.[16] Other examples of this are found in places such as China, Japan, India, and Turkey.[17]

By the late Neoproterozoic, the tectonic style along the western margin of the Yilgarn Craton appears to have become that of an extensional, rift environment, with granitoid emplacement and then granulite facies metamorphism affecting the Leeuwin Complex.[3] A geophysical (seismic and magnetics) traverse across the Darling Fault Zone supports a late Proterozoic rifting model, with evidence of extension affecting the upper 8–10 km of crust along the western margin of the Yilgarn Craton.[18] Leeuwin Complex granites have been interpreted to have resulted from intracontinental high temperature melting in a rift environment,[19] consistent with development of rifting associated with the breakup of Rodinia.[3]

A young earth Bible model

I have previously suggested that the erosion of land due to the enormous (prolonged and global) rain of the Noahic Flood can be correlated with Neoproterozoic sedimentary sequences, and that strontium isotope trends indicate Neoproterozoic continental erosion.[20] A corollary is that Archean to Mesoproterozoic rocks may be correlated with the first few days of Creation Week.[1]

"He set the earth on its foundations" (Psalm 104:5a ESV).

Mantle roots of Archean cratons may be considered as the foundations of the earth's crust during Creation Week (possibly on Day 1).[21] The Archean Yilgarn Craton was cratonized around 2,600 Ma (radiometric 'age') by the emplacement of extensive granitoids into pre-existing greenstone and high-grade gneissic belts.[3,22] This is considered to correspond to the Kenoran Event of North America's Superior Province.[23]

"And God said, 'Let the waters under the heavens be gathered together into one place, and let the dry land appear.' And it was so" (Genesis 1:9 ESV).

The 1,200–1,100 Ma peak in isotopic and geochemical signatures, identified in Western Australia's Albany-Fraser Orogen, North America's Grenville Province, and global data sets, signifies that the Grenvillian Orogeny represents a unique episode in Earth history.[24] The Grenvillian Orogeny has been correlated with crustal thickening and consequent emergence of land on Day 3 of Creation Week.[1,25]

"In the six hundredth year of Noah's life, in the second month, on the seventeenth day of the month, on that day all the fountains of the great deep burst forth, and the windows of the heavens were opened" (Genesis 7:11 ESV).

"… by His knowledge the deeps broke open" (Proverbs 3:20a ESV).

The Bible clearly states that on a specific day there was simultaneous worldwide fracturing of the earth's crust as the fountains burst forth. The phrases "fountains of the great deep burst forth" and "deeps broke open" imply rifting and fracturing of the earth's crust. The text implies that water flowed from within the earth through the fountains, and rain fell. Much of the water for the Noahic Flood may have come from various depths within the earth, with the mantle being the major water source.[21]

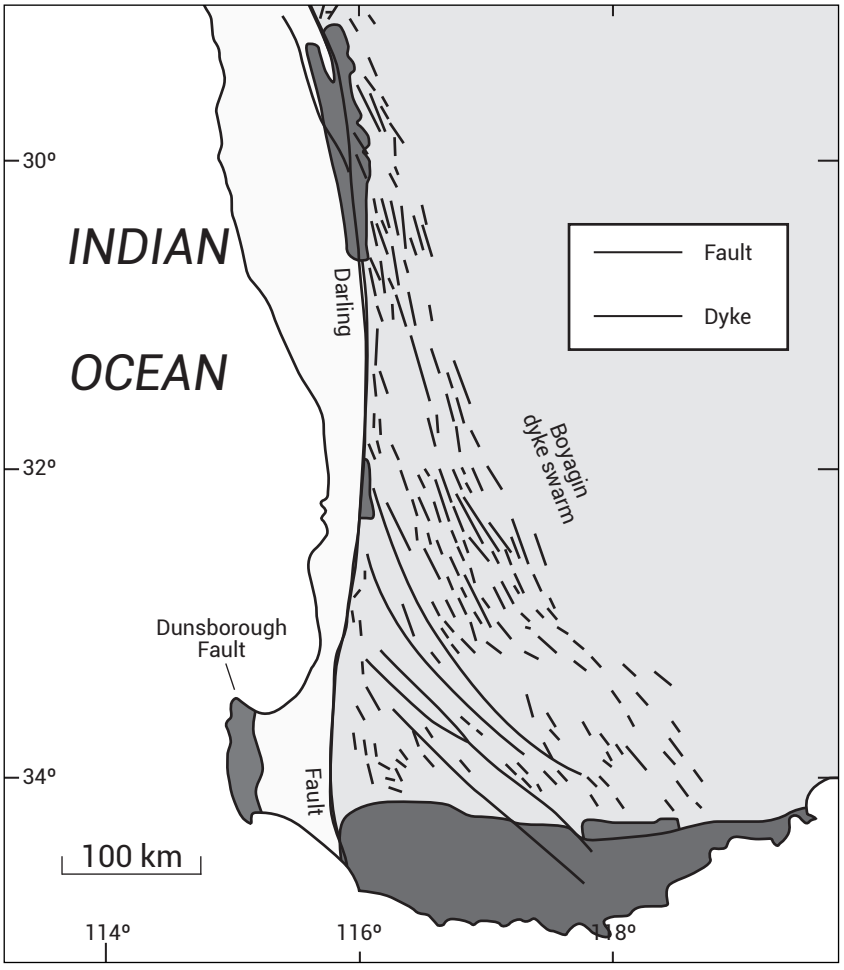

Figure 5. Late Proterozoic Boyagin dyke swarm and major faults cutting the Yilgarn Craton and Albany-Fraser Orogen (after Janssen *et al.*[11])

The term 'Pan-African' is used to describe much of the global tectonic (including rifting), magmatic, and metamorphic activity of Neoproterozoic to earliest Paleozoic geology. The Pan-African event is interpreted as a tectono-thermal event at around the radiometric 'date' of about 500 Ma ago, during which a number of orogenic belts formed, surrounding older cratons.[13] The Pan-African event is associated in secular literature with Neoproterozoic rifting of the Rodinian supercontinent.[3] This event is inferred to have initiated with the breaking open of the fountains of the great deep.[1]

The granulite facies metamorphism of the Leeuwin Complex is considered characteristic of the low-pressure metamorphism in Pan-African terranes.[3] $^{40}Ar/^{39}Ar$ 'ages' from the Yilgarn Craton's transitional domain may have been reset due to hydrothermal alteration related to Pan-African tectonism, as recorded in the Leeuwin Complex.[12] In light of $^{40}Ar/^{39}Ar$ data in the western margin of both the Yilgarn Craton and the Albany-Fraser Orogen, young biotite 'ages' have been interpreted to result principally from hydrothermal fluid alteration.[12]

In my early Flood model,[1] the vicinity of the Darling Fault is considered to be a region where continental crust fragmented and the fountains of the great deep broke open.

Rb-Sr and Ar-Ar isotope systems, petrography, and magnetotelluric data all point to a regionally extensive and major hydrothermal event around the Darling Fault. Paleomagnetic data, mafic dykes close to the Darling Fault, a seismic traverse across the Darling Fault Zone, and intracontinental high-temperature melting suggest a model of late Proterozoic rifting. This may have been associated with the breakup of Rodinia or some version of a supercontinent. In this study of southwestern Australia, all these pieces of evidence taken together are consistent with the Bible's account of the Flood event initiating as "the fountains of the great deep burst forth".

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Is the fifth toe vestigial?

Jerry Bergman

Orthodox Darwinism postulates modern humans evolved from an apelike common ancestor. Consequently, theories of human foot evolution are based on comparisons of hypothetical pre-human feet to modern chimp feet.[1] One alleged vestigial organ occasionally discussed by evolutionists is the 5th toe, also called the little or small toe.[2]

One prediction of Darwinists is that the 5th toe not only has shrunk since we supposedly evolved from our common ancestor, but will continue to shrink in the future. In 1933, from an analysis of human foot mechanics, Shapiro predicted the eventual complete loss of the 5th toe in humans.[3] His theory postulated that in the "course of primate evolution the line of leverage shifted to a position midway between the big and the second toes as a result of adaptation" to the evolution of bipedal locomotion. In other words, Shapiro hypothesized that the line of weight-bearing load in humans has moved toward the big toe as we have evolved from the chimp foot design in which the four parallel digits are all close to equal length and the 'thumb' digit is shaped very much like a human thumb.[4] As a result, evolutionists postulate the big toe has evolved to become the largest toe, accompanied by a progressive decrease in both the size and function of the smallest toe.

Kadakia has noted modern primates use their feet to grab, to claw, and to climb trees, but humans "don't need that function anymore … we're not jumping up and down trees and using our feet to grab. We have toes … because we descended from apes, but we don't need them as people."[5] Therefore, for these reasons

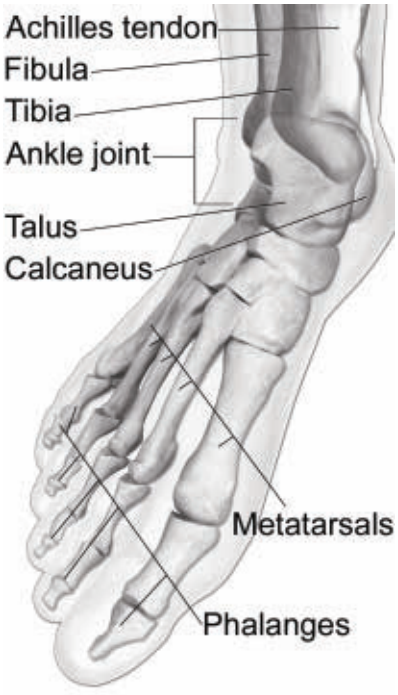
presumably the 5th toe will eventually disappear in humans.

Another argument used to support the gradual loss of the little toe is the fact that in some people it has degenerated to a tiny digit, sometimes without a nail, or only its vestige.[2] Shapiro predicted that in the future the little toe will continue to become smaller and perhaps will exist simply as a remnant of the digit in most humans. Shapiro added this suggests its total disappearance could occur in the future. Toe loss "is a phenomenon well-known in the evolution of a number of common mammals, such as the horse, cow, camel, pig, etc."[6]

Shapiro gave as a parallel example the condition of male type baldness, which is much more frequent among what Shapiro calls the "highly civilized races of mankind than among primitive people", as illustrated by the paucity of bald-headed Indians, Polynesians, and Melanesians. Assuming we evolved from an ape, he predicted that virtually all of the remaining body hair will also eventually be lost from all humans. These two examples, loss of the 5th toe and body hair, are claimed to be both the results of the disappearance of traits caused by evolution.

The design of the 5th toe

The bone at the tip of the 5th toe is the phalanx distalis (distal phalanx) which is connected to the phalanx medialis (medial or middle phalanx), in turn connected to the phalanx proximalis (proximal phalanx), connected to the os metatarsale, or metatarsal bone.This set is a very important unit that helps with balance and walking. The 5th toe is controlled by the abductor digiti minimi muscle, which serves for flexion and abduction of the 5th toe. As a result of its important role in posture and during physical activity, the abductor digiti minimi is often the target of injury. The most common of this type of injury



Lower Leg and Foot

occurs in women, possibly due to the bone's smaller size in females.

When its loss is predicted, it is not clear if it's suggested only the visible part will be lost or if the entire set of bones connected to the 5th toe noted above will disappear. If the entire set were lost, a major redesign of the foot would be required. The muscle system, and the bony structures of the 5th toe are key components in balance. The foot is a complex structure of 26 bones, 33 joints, layered with an intertwining web of more than 120 muscles, ligaments, and nerves that function as a unit. A loss of any one part affects the function of the entire system.

The blphalangeal (having two phalanges) abnormality of the big toe is significantly related to pathology.[7] These variations lend further support to the importance of the 5th toe in locomotion, further refuting the argument that it is a 'vestigial organ'.

The lack of significant selection pressures to drive any reduction in the size or function of the 5th toe is another concern. Perhaps social pressures ('neo-Lamarkian') may play a part if some isolated society ethos decided that this appendage was no longer fashionable. In view of the fact that our world is increasingly connected electronically and by airplane, this possibility is very unlikely.

The case for the 5th toe's importance

While our toes do not help us to grab trees, or anything else, they are critical in helping us to stand, walk, run, and play many sporting and dancing activities (e.g. ballet or football). Especially important are the set of bones connecting our toes to our ankle, namely the 26 bones that make up the hindfoot, midfoot, and forefoot (the toes being contained in the latter structure). The big toe consists of two large bones, while each of the rest of our toes consists of only three very small bones that function as a set. Loss of any one of these bones adversely impacts the effectiveness of the total system.[8]

Though all the bones in the foot are assembled as a functional unit forming the foot structure, the main bones responsible for our balance are the metatarsals. As explained by Wenjay Sung, walking and standing are supported by a tripod, consisting of the big toe, the 5th toe and the heel, and "If you remove one part of that tripod, you lose balance."[4] Thus, the 5th toe is part of the tripod, and its loss will force significant compensation in balance and walking, often by the 4th toe taking up the slack. Functionally, the two most important toes are the big toe and the 5th toe, as they function somewhat independently in contrast to the middle three toes. This is especially true in running. In Heinrich's words, "in order to achieve top speed, we literally run on our toes".[9]

Designed for running

University of Calgary evolutionist Campbell Rolian concluded that our short, stubby toes are custom-designed for running, noting:

> "Biomechanical analysis shows that long toes require more energy and generate more shock than short toes … . Longer toes require muscles to do more work, and exert stronger forces to maintain stability, compared to shorter toes … as we were engaged in substantial amounts of running, natural selection would favor individuals with shorter toes."[10]

Most mammals that can run efficiently, such as cats, dogs, and horses, have very short toes and often paws composed almost entirely of palms. Most primates—including our alleged closest relative, the chimpanzee—have proportionately much longer toes than do humans. Human toes are comparatively small, capable only of minor extending and flexing. Specifically, the human foot consists of only 9% of the total adult leg mass, compared to about 14% in adult chimpanzees.[11]

Research led by Rolian examined the theory that our foot's physiological design can be explained by our exceptional running skill. They found no significant increase in digital flexor energy output associated with longer toes in walking. Conversely, multiple regression analyses, based on their sample, found, when running, "increasing average relative toe length by as little as 20% doubles peak digital flexor impulses and mechanical work, probably also increasing the metabolic cost of generating these forces. The increased mechanical cost associated with long toes in running suggests that modern human forefoot proportions" confer a clear advantage in endurance running for humans.[12]

Few animals are capable of long-distance running, and fewer can do so in the blazing sun. To prevent overheating, many animals, such as wolves and hyenas, which have no sweat glands to cool their bodies, require cold weather or nightfall for long-distance hunting. This is why many large cats hunt at night. The endurance running achieved by humans sets us apart from all mammals. The best example is the human 42.2 km (26.2 miles) marathon, which very few mammals can achieve except horses, some artiodactyls, and perhaps the African wild dog (*Lycaon pictus*) under ideal circumstances.[13] One major reason is that the design of the human toes, including the 5th toe, is critical in achieving this running feat.[14]

Studies on the effect of amputation are also a source of information about the function of the 5th toe, due to the high frequence of issues reported as a result of its loss.

A very common issue, especially in women, is hammer toe involving the 5th toe, in which it overlaps the 4th toe. This is often caused by high-heeled shoes or shoes that force the feet into unnatural shapes, such as pointed-toe shoes or poorly fitting shoes. This condition causes significant problems in walking, which indicates the importance of the 5th toe.[15] Hammer toe can also be caused by lack of exercise, such as from lying down for long periods of time, diabetes, and diseases that affect the nerves and muscles.

Conclusion

This evidence supports the conclusion that the small toe is not vestigial, but serves an important role in not only balance and walking normally, but also in the exceptional human skill of endurance running and other activities, such as certain dances. The human foot is designed so that all parts function as a system, and the loss of the 5th toe results in significant loss of foot function and adaptation level. This skill (running, dancing, etc.) helps to explain the fact that a major contrast exists between the design of the human foot and that of all other primates.

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Arthropod responses to the 1980 eruption of Mount St Helens—implications for Noahic Flood recovery

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Noah's Flood was the greatest ecological disturbance in earth history, and yet Earth's biota subsequently recovered, demonstrating remarkable resilience. In similar manner, the 1980 eruption of Mount St Helens in Washington State, USA, severely disrupted a large ecosystem, the responses of which have been, and continue to be, observed and documented. General mechanisms of disturbance and principles of recovery have been delineated, which likely apply to other large disturbances, including Noah's Flood. Therefore, lessons learned at Mount St Helens should assist biblical creationists in constructing a model for post-Noahic Flood biological recovery. This article looks at one facet of the Mount St Helens eruption—the impact on arthropods and their subsequent responses to disturbance, including the following topics: high mortality, biological legacies, dispersal, role in primary succession, enrichment of developing soils, alteration of successional trajectories, and great resilience. Implications for a post-Noahic Flood recovery model are discussed.

Noah's Flood was the most catastrophic ecological disturbance in the history of the earth. Occurring several thousand years ago, it severely disrupted biological systems on the entire planet (Genesis 7: 21–23; 2 Peter 3:6). Yet, following the Flood, the biota recovered, producing the forests, grasslands, deserts, tundra, and other biomes of the post-Flood world (Genesis 8:11; Genesis 14:13). Both skeptic and believer might ask whether such amazing transformations are possible, and, if so, by what ecological processes they would occur.

An important source of information in attempting to answer such questions is the study of modern disturbances, including those caused by wildfire, windstorm, local flooding, disease, avalanche, and glaciation. But of far greater intensity than these is volcanic eruption, and no eruption has been documented, either geologically or biologically, nearly as well as was the 1980 eruption of Mount St Helens in Washington State.[1] One would think, therefore, that a careful review of lessons learned at Mount St Helens would reveal general principles of disturbance recovery,[2] which would shed light on processes operating following Noah's Flood.

This article examines biological recovery at Mount St Helens from the standpoint of terrestrial arthropods,[3] which have been the subjects of several studies. Attention will be given to predisturbance arthropods and their habitats, the disturbance itself, and ecological responses of arthropods to the disturbance. Lastly, implications for understanding biological recovery following Noah's Flood will be discussed.

Predisturbance setting

Prior to its 1980 eruption, Mount St Helens was a 2,950 m ASL (above sea level) stratovolcano located on the west side of the Cascade Mountain Range in the state of Washington, USA.[4] It was known to be active, having last erupted in 1857. The mountain's summit and upper slopes were seasonally clad with deep snowpack and also supported about a dozen glaciers. Alpine meadows occupied high and medium elevation sites. Below timberline, and extending onto the surrounding landscape, grew expansive old-growth, plantation, and recently clear-cut coniferous forests. Several mountain lakes, the largest being Spirit Lake, lay to the north and streams draining the area emptied into the Columbia River. The climate was Pacific maritime, with a mean annual precipitation of 2,373 mm at an elevation about 1,000 m ASL.

Pre-1980 Mount St Helens provided manifold habitats for a diverse assemblage of arthropod species. Unfortunately, this arthropod diversity was not well documented.[5] The most comprehensive inventory for a westside forest in the Cascade Range is from the H.J. Andrews Experimental Forest, an ecological research site located 200 km to the south.[6] Containing over 4,000 arthropod entries, it approximates a baseline species list for pre-eruption Mount St Helens.

The disturbance

The 1980 eruption of Mount St Helens was a complex event involving diverse geological processes which

interacted with the pre-disturbance landscape to form a mosaic pattern of multiple disturbance zones.[7,8] A gradient of disturbance was established, extending from areas near the mountain, where intense processes eliminated all pre-eruption organisms, to distant sites, where limited disturbance allowed survival of most organisms. Five major disturbance processes and the zones of disturbance they formed are as follows (figure 1):

1. *Debris avalanche*: The eruption began with a 5.1 Richter magnitude earthquake, which triggered a massive debris avalanche composed of the mountain's summit and north flank.[9] Part of this landslide travelled through Spirit Lake, generating a giant oscillating wave extending 260 m up onto adjacent mountains. The wave brought thousands of logs and other forest materials back into Spirit Lake, forming a giant floating log mat occupying about 40% of the lake's surface.[10] Most of the remaining avalanche material entered the North Fork Toutle River Valley where it buried 60 km^2 of land with deposits having a mean depth of 45 m.
2. *Directed (lateral) blast*: The debris avalanche exposed magma inside the volcano, along with superheated water, resulting in a north-directed, lateral, ground-hugging blast, which devastated 600 km^2 of forest within less than 10 minutes.[11] In most of this area, trees were flattened (blowdown zone), except at the periphery, where they were heat-killed but left standing (scorch zone). The landscape impacted by the directed blast is now known as the 'blast zone'.
3. *Vertical eruption*: Following the lateral blast, Mount St Helens produced a vertical eruption plume for 9 hours, resulting in a continuous rain of tephra (ash and pumice fragments) on the blast zone and extending hundreds of kilometres to the east (figure 2).[12] The erupted material was composed of a silica-rich, nutrient-poor volcanic rock called 'dacite'.
4. *Pyroclastic flows*: In the afternoon of May 18, incinerating pyroclastic flows of pumice spilled from the crater onto debris avalanche deposits north of Mount St Helens, forming the 15 km^2 Pumice Plain.[13]
5. *Mudflows (lahars)*: Heat from the eruption rapidly melted the mountain's winter snowpack and glaciers. The runoff mixed with volcanic debris, forming mudflows, which travelled down streams draining Mount St Helens, leaving deposits.[14]

The complex landscape produced by these processes forms the stage on which the drama of biological recovery is playing.

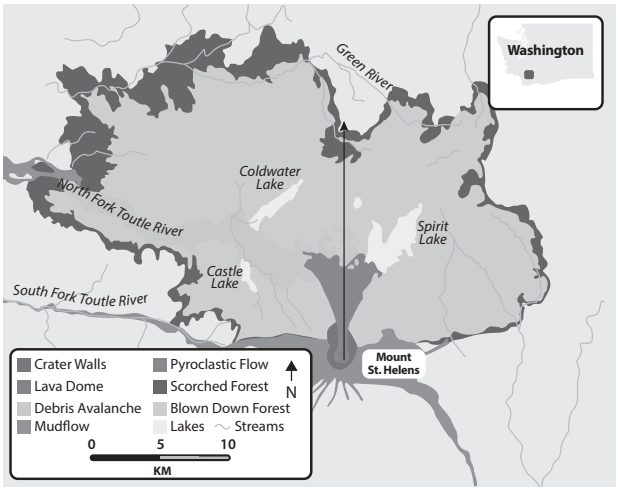

Figure 1. This map of the blast zone shows disturbance zones, including: debris avalanche deposit, forest blowdown zone, scorch zone, Pumice Plain, and mudflow deposits. The arrow represents a gradient of disturbance, which depicts a progressive decline in disturbance intensity between the Pumice Plain and the intact forest.

Figure 2. On 18 May 1980, Mount St Helens erupted a plume of ash extending upward over 20 km and lasting 9 hours. Ash reached the Atlantic coast in 3 days and circled the earth in 2 weeks.

Arthropod responses to disturbance

Arthropods experienced high mortality

Untold billions of arthropods succumbed to the 1980 eruption of Mount St Helens due to high-impact forces, extreme heat, abrasion, and deep burial.[15]

Additional mortality resulted from the insecticide effect of dry volcanic ash on arthropod populations,[16] not only within the blast zone, but extending hundreds of kilometres eastward within the tephra deposit left by the advancing ash plume. Ash killed by physical, not chemical, means. Tiny, sharply angular particles abraded the moisture-retaining, waxy cuticles of exoskeletons, causing arthropods to desiccate and die. Laboratory crickets and cockroaches exposed to Mount St Helens ash also salivated excessively trying to clean ash from themselves, thus adding to their water loss. To complete the insult, ash clogged respiratory spiracles and intestinal tracts.

Following the eruption, private timber companies, along with governmental agencies, argued for large-scale salvage logging of the blast zone, one reason being to prevent beetle (*Dendroctonous pseudotsugae*, *Pseudohylesinus granulatus*, and *P. grandis*) infestations in the dead trees, which might have then spread to live trees. The fact that such outbreaks never occurred is attributed to the insecticide effect of volcanic ash.[17]

Another example of ash-induced mortality was found in September, 1980, within the blowdown zone northeast of Mount St Helens. A massive die-off of yellow-spotted millipedes (*Harpaphe* sp.), an important decomposer species, occurred after these organisms ingested ash-coated forest floor litter, obstructing their guts.[18]

Arthropods became biological legacies

Even though mortality was high, many arthropods survived the eruption. Several factors favoured this, including the organisms' small size, cryptic habits, and complex life cycles, often including egg, larval, pupal, and adult stages.[19] Survival was generally in protected sites termed 'refugia', such as rock crevices, talus slopes, ice-covered ponds, soil, and dead wood. For example, Edwards, in the summer of 1980, observed western carpenter ants (*Camponotus modoc*) foraging for windblown insects on a barren, sunbaked pumice surface.[20] Nearby, the ants' colony was found residing in a large log, which had been buried deeply in winter snowpack at the time of the eruption. It had served as a 'life boat', preserving the ant colony, allowing it to emerge onto the post-eruption landscape.

A new term, 'biological legacies', was coined at Mount St Helens for all biological materials, both living and dead, that persisted into the post-disturbance period.[21] It was discovered that the quantity and type of biological legacies in an area was the most important determinant of the pace and pattern of subsequent ecological development. Sites high in biological legacies quickly formed 'hotspots' of life, from which organisms spread outward into less populated territories.[22]

Figures 3. This spider (Araneae), photographed on the debris avalanche at Mount St Helens, either dispersed into the blast zone by ballooning or is descended from spiders that did.

Arthropods dispersed into the blast zone

Arthropods from the surrounding landscape wasted no time dispersing into the blast zone, joining the survivors. Edwards wrote:

> "Even before the tumultuous events following the lateral blast were complete, arrival of microorganisms, arthropods, and perhaps plants had begun. We know from reports of the first humans on the scene (the crews of rescue helicopters) that flies, yellowjackets and other conspicuous insects had preceded them."[23]

The air column each summer is alive with a host of dispersing insects, spiders, and other organisms. Coad, by

attaching sticky traps to aircraft, found abundant insects up to 4,572 m over Louisiana,[24] while Hardy and Milne, using towed nets fastened to kite lines, estimated that there were about a million insects in a 2.6 km^2 of air column between 46 and 610 m.[25] Witness also the high-flying foraging of swallows, swifts, and bats. Of course, small organisms, lofted by prevailing winds, eventually are deposited at distant sites, including the blast zone at Mount St Helens.

Prominent among this 'arthropod fallout' on Mount St Helens were dispersing juvenile spiders (figure 3). Many arachnid species ride the wind in a process known as 'ballooning'.[26] Juveniles perch on vegetation and release lengthy silken threads into the air currents. These act as kites or balloons and transport young spiders tens of kilometres. University of Washington spider researcher Rodney L. Crawford identified over seventy-five species of spiders which ballooned onto the Pumice Plain.[27]

In addition to sampling arthropods with standard pitfall traps, scientists at Mount St Helens developed a unique device for collecting arthropod fallout. It consisted of a 0.1 m^2 frame filled with a layer of golf balls, designed to simulate the desert pavement surface of the Pumice Plain.[28] Arthropods falling among the golf balls were periodically retrieved, identified, dried, and weighed. Calculations revealed that approximately 36 kg of arthropods (dry weight) landed per acre each four-month growing season.[29] Species, in addition to spiders, included flies (Diptera), beetles (Coleoptera), true bugs (Hemiptera), wasps (Hymenoptera), butterflies and moths (Lepidoptera), lacewings (Neuroptera), and others.[18]

Arthropods initiated primary succession

Prior to the 1980 eruption of Mount St Helens, the site of the Pumice Plain was old-growth forest, a haven of life. However, the eruption blasted, incinerated, and deeply buried it with deposits tens of metres thick, thus extinguished all organisms.[13] The resulting Pumice Plain provided 15 km^2 of sterile substrate, a perfect location within which to observe and document primary succession.[30]

The reigning hypothesis in 1980 held that plants and lichens would be the initial macroscopic organisms to colonise the Pumice Plain. However, the first species to establish were not plants, but various insects and spiders of the arthropod fallout.[31] Most proved unfit for the harsh conditions and died. Some, such as spiders, lived but failed to reproduce. The first colonists to establish breeding populations were scavenger and predatory beetles, largely of the Family Carabidae (ground beetles).[32] Most successful of these was *Bembidion planatum*, a carabid beetle known as a 'pioneer', specializing in highly disturbed habitats.

But what provided food for these pioneer species? It turned out that they fed exclusively on their fellow arthropod fallout companions, both living and dead.[33] Such a habitat, in which resident organisms depend solely on inputs of nutrients transported by wind, is termed an 'Aeolian zone'.[34] This situation may not be rare. Edwards and Sugg suggest the pattern is a "widespread and perhaps a general one for terrestrial primary successional habitats" and that "comparable pioneer predatory and scavenging arthropods operate around the entire Pacific Ring of Fire and other volcanic areas, wherever volcanic activity produces new surfaces".[35]

After 3–4 years, as plants established on the Pumice Plain, the arthropod fauna began to change. Paramenter documented the decline of *B. planatum* and its replacement by a relay-like series of beetle species, each adapted to its prevailing environment.[36]

Arthropods enriched developing soil

The newly deposited pyroclastic-flow and tephra surfaces of the Pumice Plain lacked nutrients essential for life. Measured values of nitrogen and organic carbon were zero[37] and available phosphorus was likewise low.[38] However, repeat determinations for the same elements in 1985 showed significantly increased values.[39] A major source of these added nutrients was atmospheric fallout of arthropods.

Based on analysis of debris obtained from the 'golf ball' fallout collectors and other determinations, it was estimated that arthropods contributed a minimum of 80 mg of fixed nitrogen and 5.5 mg of phosphorus per square metre annually.[40] Notably, plant material is deficient in phosphorus, so the input of this element was mostly from arthropods.

Another example of arthropod-mediated nutrient enrichment of developing soil involved mosquitoes and the degraded water of Spirit Lake.[40] The giant wave that emanated from Spirit Lake on the morning of 18 May 1980 washed part of an old-growth forest back into the lake. Combined with volcanically warmed water, this vegetation rapidly produced a nutrient-rich organic brew which became the substrate for a massive bacterial bloom that depleted all the lake's oxygen. Under these anoxic conditions, only anaerobic organisms existed in the lake, with one exception, that being mosquito larvae.

Although requiring oxygen, mosquito larvae thrived in the lake due to their snorkel-like siphons through which they obtain air. Large numbers of the resulting adult mosquitoes were subsequently captured on the Pumice Plain, several kilometres distant from Spirit Lake. This situation persisted for up to two years and is a remarkable example of an arthropod species ferrying essential nutrients from a rich source area to nutrient-deficient developing soil.

Atmospheric fallout of arthropods (along with dust, microorganisms, and plant materials) provided nearly all of the nutrient input on the Pumice Plain for the first few

years of recovery. Thereafter, plants established and also contributed to nutrient enhancement of the substrate.

Arthropods altered the trajectory of succession

As plants progressively colonise the blast zone, so do associated herbivorous insects, which sometimes restrict plant growth and spread. In so doing, herbivores alter the trajectory of community succession (figure 4). Prairie lupine (*Lupinus lepidis* var. *lobbi*) provides an example.[41]

Although ground beetles were the first organisms to colonise the primary successional surfaces of the Pumice Plain, plants were not far behind. In the summers of 1981 and 1982 researchers found isolated individuals of prairie lupine, the first plant coloniser of the Pumice Plain.[42] This low mat-forming subalpine herb arrived as wind-dispersed seeds, blown from source areas several kilometres away. The plant's prolificacy astounded researchers. One carefully monitored founder plant grew to a large patch of 24,000 individuals by 1985![43]

Besides being a successful primary producer, prairie lupine performs several other important functions. Foremost among these is nitrogen fixation.[41] Associated with lupine are nitrogen-fixing bacteria (*Rhizobium*) which live symbiotically within small root nodules. These microbes transform atmospheric nitrogen, which plants can't use, into nitrogen compounds, usually ammonia (NH_3), which plants readily utilize. Lupine thus adds usable nitrogen, along with organic carbon, to nutrient-deficient pumice deposits.

In addition, mats of prairie lupine trap wind-blown plant propagules and organic detritus.[41] Several species of plants, derived from wind-dispersed seeds, have colonised lupine patches, taking advantage of the nutrient-enriched soil. One example is paintbrush (*Castilleja miniata*), which is hemiparasitic on lupine. Others, such as fireweed (*Chamaenerion angustifolium*), pearly everlasting (*Anaphalis margaritaceae*), seedling conifers, and various grasses add vertical structure to developing communities, attracting pollinating and herbivorous insects, birds, rodents, and elk (*Cervus elephas*).

Because of its diverse and critical functions, prairie lupine has earned the designation of 'keystone species'.[44,45] It follows, therefore, that any organism which regulates the growth and spread of prairie lupine is also of great ecological significance.

Prairie lupine grew and spread unfettered in the early years after the eruption, but by the latter 1980s many lupine patches were in decline and their rates of spread greatly reduced. A likely cause became apparent in 1985 when the first herbivorous insects, root-boring moth larvae of the Family Tortricidae, were observed.[46] By consuming root vascular tissues these insects produced a die-off, particularly on the advancing edges of lupine mats, thus slowing the plant's spread. Despite initial explosive growth, Bishop's survey in 2002 found that lupine was still absent or in low density on 70% of the Pumice Plain. Bishop concluded: "Given the known effects of prairie lupine on soil and community development on the Pumice Plain, herbivory on prairie lupine has likely altered the pace and pattern of succession."[47] Continued observation has shown that other Pumice Plain plant species[48] are similarly affected by herbivorous insects, often producing major 'boom-bust' population cycles.[49]

Arthropods demonstrated remarkable resilience

Scientists observing the monotonous grey of the blast zone following the 18 May eruption voiced dire predictions concerning the return of life. Forest ecologist Jerry Franklin referred to an 'apparently sterile landscape'[50] and silviculturist Eugene Sloniker commented, "If anything, we were anticipating the worst, that maybe the entire ecology of the area had changed".[51] Researchers, A.B. Adams and S. Leffler lamented, "There seemed to be justification to believe that it would be impossible for insects to recover at all."[52]

But the resilience[53] of the Mount St Helens' ecosystem was greatly underestimated. Franklin subsequently observed: "But ecological recovery has been generally rapid. Three years later, 90% of the plant species that originally inhabited the area could be found",[49] and Adams and Leffler noted that "insects have been quick to recolonise the blast zone".[52]

Was the initial pessimism warranted? And should the remarkable resilience have been a surprise? No! The

Figure 4. Herbivorous insects, such as this grasshopper (Orthoptera), resting on a pumice deposit at Mount St Helens, help control plant growth and spread. By so doing, they alter the trajectory of community succession.

pre-eruption organisms at Mount St Helens, and surrounding areas, were already highly adapted to major disturbances. They had "been there ... done that"— as the saying goes. Edwards expressed it this way: "The plant and animal species that are returning to the mountain's slopes have seen it all before; for them, as species, it was no unique event, and our studies of colonization must take this into account."[54]

It is important to recognise that arthropods play numerous critically important roles in ecosystem function. They are involved in herbivory, granivory, pollination, predator-prey interactions, parasitism, pathogenesis of diseases, decomposition and nutrient cycling, soil dynamics and other processes. High arthropod resilience, therefore, is essential for optimal ecosystem responses to major disturbances.

Implications for post-Noahic Flood recovery

Volcano ecology is an emerging discipline concerned with ecological responses to volcanic disturbances.[2,55] Much early research in this field was limited because it was begun years or decades (or longer) following an eruption and often focused on only one subject, such as plants.[1] Studies of three eruptions stand out as the most significant: Krakatau, a catastrophic eruption on an Indonesian island in 1883;[56] Surtsey, a new island produced by a submarine eruption off the coast of Iceland in 1963;[57] and Mount St Helens in 1980. Of these, Mount St Helens has been the most productive, generating almost 40% of the world's literature on ecological responses to volcanic eruption.[58] Most Mount St Helens studies were initiated shortly after the 1980 event and were continued for at least several years. Research at Mount St Helens has also been multifaceted, covering most relevant topics, including arthropods.

An important issue in volcano ecology is whether or not biological responses observed at one volcano also apply to other volcanoes, or even to other types of disturbances. That is, do some processes achieve generality or universal status? It is reasonable to think this would be the case because diverse disturbances often produce common mechanisms, which are experienced by organisms, including excessive heat, high impact forces, abrasion, and deep burial.[21,59] For example, both volcanic eruption and flooding deeply bury organisms in sediments. Likewise, heat from either a forest fire or a volcanic flow can stimulate spores of certain fungi to germinate.[60]

Crisafulli believes there is significant commonality between different types of disturbances. Comparing Mount St Helens with Krakatau and Surtsey, he states: "We can tease out idiosyncrasies of individual eruptions versus overarching generalities. The biological agents may vary but the ecosystem processes may be quite similar".[58] And a publication of the U.S. Forest Service reads: "The in-depth ecological research on Mount St Helens and at other volcanoes is enabling researchers to identify universal themes in ecosystem response to disturbance" and "This means the lessons learned here can be relevant in other disturbance settings."[61]

Certainly, there are many similarities between Noah's Flood and the eruption of Mount St Helens. Both were cataclysmic geological events involving volcanism, flooding, and the destruction of a predisturbance ecosystem, in which most organisms perished, but some also survived. And following both events, ecological processes assembled functioning ecosystems. However, there are also major differences, the foremost being that Noah's Flood was global and the eruption of Mount St Helens regional. Dispersal distances were generally small at Mount St Helens because most colonising organisms originated in the surrounding intact forest.[62] In contrast, following Noah's Flood, dispersal for some species on the Ark was global. Finally, the end product at Mount St Helens will be an ecosystem similar to that which existed prior to the eruption. Following Noah's Flood, it is unlikely that ecosystems in any given area closely resembled corresponding pre-Flood ecosystems.

Another issue is whether or not arthropods were among the animals specifically directed by God to Noah's Ark for preservation. Or did they survive as biological legacies outside the Ark (except for incidental 'hitchhikers' on the Ark)? The majority view among biblical creationists is that arthropods primarily survived outside the Ark. The Bible states: "Everything on dry land that had the breath of life in its nostrils died" (Genesis 7:22). This included all terrestrial vertebrates, but not invertebrates, as they do not 'breathe' through nostrils. Insects, for example, obtain atmospheric oxygen through pores on their bodies called 'spiracles'. In addition, Scripture indicates that "every living thing on the face of the earth" died; only those on the Ark survived (Genesis 7:23). If the 'Ark kinds' all perished outside the Ark, and that included arthropods, then no insects survived in the floodwaters. That hardly seems possible, given the numerous opportunities for arthropod legacies detailed below. A good case can also be made that the Bible does not consider arthropods and other invertebrates to be 'living creatures' (Hebrew: *nephesh chayyah*).[63]

The discovery of universal themes in volcano ecology, as well as similarities between Mount St Helens and Noah's Flood, encourage us to apply lessons learned at Mount St Helens to post-Noahic Flood recovery. However, differences between the two events mandate caution. Any model of post-Flood recovery is speculative and should be held with humility. Several principles learned at Mount St Helens that likely do have application to the post-Noahic Flood period will now be discussed.

Principles from Mount St Helens

The concept of biological legacies,[21] developed at Mount St Helens, probably applies to most, if not all, disturbances. Arthropod legacies in Noah's Flood likely included aquatic insects in the floodwaters, terrestrial arthropods within huge floating vegetation mats (including inside coarse woody debris),[64] flying insects, passively dispersing arthropods lofted into the atmosphere, and arthropods as incidental passengers on the Ark. In addition, large floating pumice rafts produced by undersea volcanic eruptions have been documented to harbour marine organisms (coral, algae, crabs, anemones) and transport them thousands of kilometres.[65] Probably, numerous such rafts formed during the Flood and, in addition to marine organisms, supported an aeolian community of terrestrial insects and spiders acquired from atmospheric arthropod fallout. Following the Flood, arthropod biological legacies were immediately available to colonise suitable sites over the entire earth.

Colonizing arthropod populations, derived from legacies, would have expanded rapidly, perhaps, even explosively.[66] Food was abundant after the Flood, in the form of animal carcasses, plant debris, newly emerging fungi and plants, and arthropod fallout. Initially, checks and balances on these arthropod populations would not have had sufficient time to establish. For example, insectivorous vertebrates (lizards, bats, rodents, swallows, and many others) on the Ark would have required weeks, months, or years to disperse globally. Also, early in recovery, there would have been few competitor organisms. One control over burgeoning arthropod populations during this time most likely was 'insecticide ash' from erupting post-Flood volcanoes, producing effects similar to those observed at Mount St Helens.[16]

As the floodwaters subsided, massive floating vegetation mats, composed of plant and animal legacies, grounded, producing large, expanding 'hotspots' of biological activity. These oases likely functioned as source areas for organisms, including arthropods, which dispersed into nearby 'coldspots' (areas with few or no biological legacies). Dispersing arthropods would have used methods observed at Mount St Helens, including pedestrian travel and aerial dispersal, such as ballooning of spiders. For example, scavenging and predatory beetles (or other species) from the arthropod fallout likely initiated primary succession by forming aeolian communities on sterile lava flows and pyroclastic deposits produced by erupting post-Flood volcanoes. Arthropod fallout would also have provided an important initial and ongoing influx of nutrients, facilitating soil development and plant establishment.

Colonisation of recovering sites by herbivorous insects probably limited growth and spread of specific host plant species. This would have altered successional trajectories and produced large population swings as observed with prairie lupine and other plant species on the Pumice Plain at Mount St Helens.[40,48]

Terrestrial vertebrates, dispersing from the Ark following Noah's Flood (Genesis 8:19), repopulated the earth more slowly than organisms distributed worldwide by receding floodwaters. This would allow time for significant development of microbial, fungal, plant, and invertebrate communities prior to the arrival of dispersing birds, mammals and, eventually, humans.[67] Arthropods, therefore, likely provided an immediate global food supply for dispersing insectivorous vertebrates.[66]

The overarching recovery theme at Mount St Helens is that of great resilience. Ecosystems appear to have been designed with the ability to effectively respond to major disturbance. This observation lends credibility to global recovery, within a biblical timeframe, following the ecological cataclysm of Noah's Flood. Arthropods certainly played an important role in that response.

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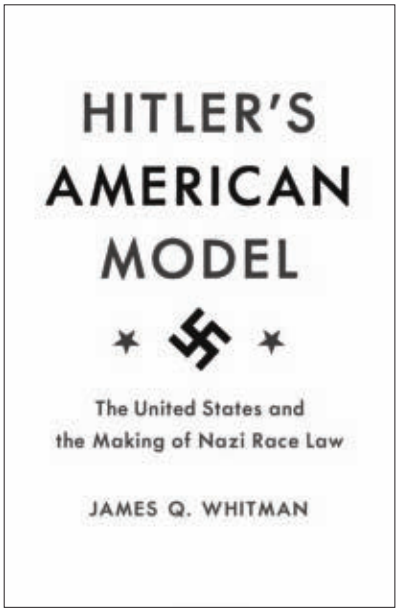
Nazi racist copycats

Hitler's American Model: The United States and the making of Nazi race law

James Q. Whitman

Princeton University Press, Princeton, NJ, 2017

Jerry Bergman



This book documents the major influence of American law and policy on Nazi Germany relating to inferior race claims based on Darwinian eugenics. Dr Whitman is well qualified to write on this topic, as he is Professor of Comparative and Foreign Law at Yale Law School and also has a Ph.D. in history. He concludes that only two nations in history have ever formally, in detail, codified racism, the United States and Nazi Germany. While the United States was the leader in racist law, it was not the only country that passed racist laws (p. 138). For example, South Africa penalized extramarital sex between some races while those same races were free under the law to intermarry. America, on the other hand, did not penalize extramarital sex between blacks and whites but most states outlawed interracial marriage (p. 79). Whitman also documents the fact that the Nazi Holocaust was the result of intensive work by leading American and German scientists, lawyers, and other professionals, especially in the medical field, including both doctors and nurses. Hitler was "praising America well before the Nazis took power" for its racist practices, such as its Jim Crow and other laws that limited the activities of Blacks, such as separate accommodations (p. 53). In "*Mein Kampf* Hitler praised America as nothing less than 'the one state' that had made progress toward the creation of a healthy racist order of the kind the Nuremberg Laws were intended to establish" (p. 2).

The Nazis also saw much to despise in America's traditions, including the commonality of mixed marriages between the Aryan race and what they viewed as less evolved races, such as the Slavic peoples, especially Poles. Whitman also realizes that the topic he has spent several years researching may make him some enemies, but concludes that the history must be documented in detail. He points out that his is the first extensive study of this neglected topic, although he notes that other historians have come to the same general conclusion as he has.

As Whitman wrote, during the period immediately following WWI, "the United States was not just a global leader in assembly-line manufacturing and Hollywood popular culture. It was also a global leader in 'scientific' eugenics" (p. 8). As a result, the Nazis "looked to the United States as a 'model' … [and] there was an active back-and-forth traffic between American and Nazi eugenicists" (p. 8). In the end, "American law remained a regular Nazi point of reference, just as it had been for Hitler before. America remained the leader, and the Nazis repeatedly turned to the American example when developing their own immigration and citizenship law" (p. 50). This and similar statements were backed up by 31 pages of small print notes, including many sources in the original German, a language the author reads and writes fluently.

The 1935 Nuremberg Laws were designed to reduce the eugenic degeneration of the superior Aryan race. Included in the Law was the "Protection of German Blood and German Honour", which forbade marriages, and all extramarital intercourse, between Jews and Germans (pp. 24–25; figure 1). The Nazis had to rely on the American experience because there "were no other models for miscegenation legislation that the Nazis could find in the world" (p.12). To reduce the likelihood of superior races breeding with inferior races, the Nuremberg Laws also forbade the employment of German females under age 45 in Jewish households. Also, part of the law was the Reich Citizenship Law, which declared that only those of German, or closely related, blood were eligible to be Reich citizens. Jews and other less evolved races ('*Untermenschen'*) were classed as state subjects without citizenship rights. This was the first step that led to the Holocaust.

The Holocaust developed gradually over the 12 years of Nazi rule of Germany, which imposed its ideology on the conquered nations in WW2. After Hitler's ascent to power he left the non-German race question to the lawyers, academics, and eugenicist experts (p. 50). Professor Otto Koellreutter (1883–1972), chair of Public Law in Munich, was one of the prime leaders dealing with the legal aspects of racism in Germany. Nazi lawyers regarded America "as the innovative world leader in the creation of racist law" they used as

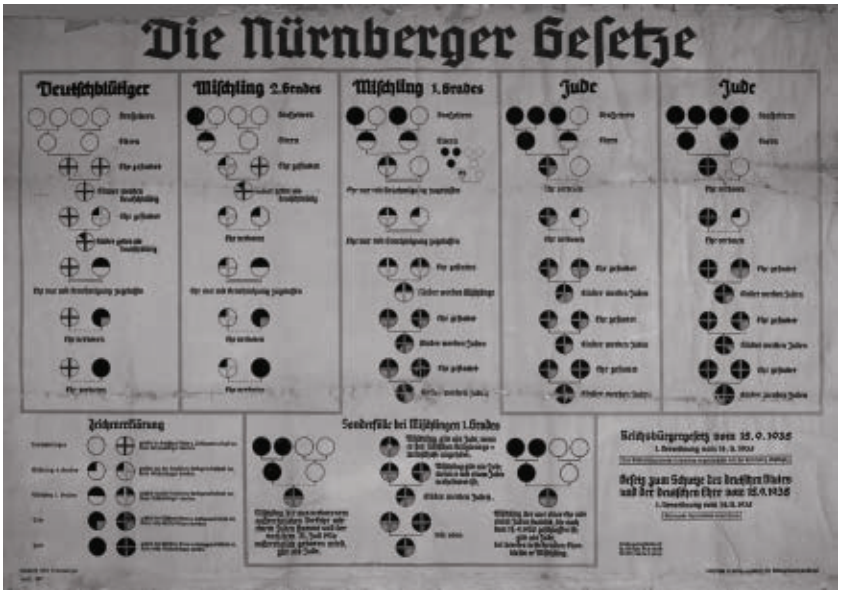


Figure 1. Because of widespread intermarriage, to implement the Nuremberg law required the above complex chart to determine who was a Jew

a basis for developing German racist laws (p. 5). The leading Nazis wanted to "reach out the hand of friendship to the United States on the basis of a shared commitment to white supremacy" (p. 7).

The Germans were very careful to do everything, initially at least, strictly according to law. In the early 1930s, racial annihilation was even 'difficult to imagine' by Germans until many years later. It was not to emerge until 20 January 1942, when 15 high-ranking Nazi Party and German government officials gathered in the Berlin suburb of Wannsee to discuss and coordinate the implementation of what they called the "Final Solution of the Jewish Question" (pp. 48–49). Until then, the proposed solution to the problem was far less drastic, namely to force Jews to emigrate, ideally by persuasion but, if necessary, by coercion such as by street violence. Although the Nuremberg Laws stripped Jews and others of German citizenship, they were still protected under the law (p. 49).

An important inspiration for Nazi Germany was the American immigration laws. For most of American history, the United States was a refuge for both the oppressed and others. It was only in 1879, when bills banning Chinese immigration were enacted by congress, that this began to change. In 1921 (i.e. after WWI), an American quota law inspired by Darwinian Eugenics, which restricted the immigration of races regarded as inferior, heralded the beginning of a drastic change. It was these American laws to which Germans paid very close scholarly attention.

U.S. court decisions, especially regarding immigration policies and what some call the genocide of Native Americans, were major sources of inspiration behind Nazi policy against both the Jews and other people that the eugenic scientists considered members of inferior races. American policy also was very influential in inspiring the Nazi goal of *Lebensraum*, expanding the Germanic population into the East and reducing, or making slaves of, the Slavic peoples (Poles, Russians, and other Eastern populations) that lived in the East (note that the word 'slave' is derived from Slav).

Following Hitler's rise to power, *Lebensraum* became an ideological goal of Nazism and provided justification for German territorial expansion into East-Central Europe. The native populations of America were decimated by wars, relocation to reservations, murder, and disease, which many saw as God's will to allow Europeans to move into the area. Consequently, the Nazis reasoned, that was hardly any different from the decimation of the native population of Eastern Europe to allow ethnic Germans to move into the land the Slavs once occupied. Some even referred to Ukrainians and other Slavic people as 'Indians'. The Nazis also studied the situation of 'second-class' citizens in America, specifically Blacks, Puerto Ricans, Filipinos, Chinese, and Native Americans, reporting their findings in various books published in Germany (pp. 59–65).

Land reservations for Native Americans was a factor justifying the concentration camps for Jews, only a few of which were officially death or extermination camps. (This is not to deny the fact that many thousands were murdered in the concentration camps, or died because of the deliberately atrocious conditions.) This is one reason why the Nazis were able to get away with carrying out the Holocaust for so long. It was not until after World War II when the Allies liberated the death camps that we knew for certain the extent of the Nazi genocide goal. The main extermination camps were Treblinka, Bełżec, Chełmno, and Sobibór, which served as 'death factories', each murdering hundreds of thousands with carbon monoxide. Auschwitz II–Birkenau was a combination concentration/extermination camp which murdered the most of all, about 1.1 million, using cyanide.

Anti-Semites, eugenicists, and racists inspired by Darwinism in the US helped to inspire those in Germany, and vice versa. The US was "a global leader in 'scientific' eugenics", so naturally the German scientists would have to rely on American research and law (p. 8). The author covered only

briefly the well-documented important influence of Darwin and mentioned evolution only in connection with the evolution of racism (p. 114). Conversely, he discussed the eugenics idea and movement 28 times, such as on page 8, where the author documents that eugenics was the basis of both the Nazi German and American discrimination laws and policy.

The support of the US policy to Nazi Germany went well beyond the eugenics contribution. United States bankers and industry, even the weapons industry, invested heavily in the Nazis' war machine. Nazis borrowed ideas from US books, such as the American racist best seller titled *The Passing of the Great Race* and other propaganda developed during World War I (p. 8). This 1916 book on scientific racism by American eugenicist, lawyer, and anthropologist Madison Grant (1865–1937; figure 2) advocated creating a eugenics program for the Nordic population, and is considered one of the major works of 20th century racism based on eugenics.

Grant's book drew on the scientific theories of genetics, the then-known writings of previous eugenicists, and especially Darwinian evolution, to create a clearly written synthesis aimed at general readers. The 1918 revised edition was endorsed by several leading American biologists including Columbia University Professor, and later President of the American Museum of Natural History, Henry Fairfield Osborn, Sr (1857–1935; figure 3). In his Preface, Osborn listed the greatest danger in America as the replacing of Nordic races by those he deemed inferior.[1] Adolf Hitler wrote to Grant to personally thank him for writing it, referring to Grant's book as 'my bible'.

Figure 2. Madison Grant

The US immigration laws that Germany relied on to craft their own laws blocked admission of significant numbers of Jewish refugees. A notorious example was refusing admittance of over 900 Jewish refugees who sailed on the *St Louis* from Hamburg, Germany, to the West in 1939. The ship was forced to return to Europe, where many of the Jews on the ship later died in Nazi German camps. The most infamous example is when the State Department rejected the Frank family's attempts to enter the United States, including the teenaged diarist Anne Frank (pp. 53, 116, 149).

Another area of special interest to the Nazis was laws against Whites marrying Blacks, usually black men marrying white women. Anti-miscegenation laws had been in place in 30 states in the United States since colonial days (p. 78). Marriage to a slave was never legal and Black-White intermarriage was illegal in all the seven states of the lower South. Furthermore, those who entered such a marriage sometimes faced harsh penalties including fines or even jail terms.

A major concern in America was how to draw the line between Blacks and Whites in a society in which white men had many children with black slave women. Most American laws used the 'one drop of blood' rule, which meant the law was one black ancestor made a person Black. The Nazis thought this too restrictive and, after debating such concerns, such as whether two or three Jewish grandparents made one a Jew, ended up with a very complex set of laws. In the end, leading Nazis reportedly stated, "we will determine who is a Jew", because some important German generals and others were Jewish by German definition.

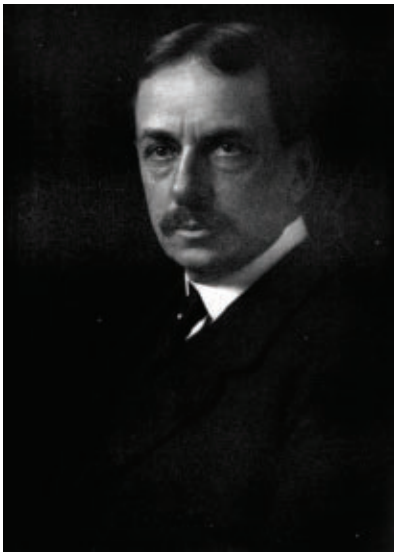


Figure 3. Henry Fairfield Osborn, Sr

In America, laws against intermarriage changed only in 1967 when the Supreme Court case Loving v. Virginia, 388 U.S.1, invalidated all laws prohibiting interracial marriage. Ironically, interracial marriage, rather than causing the degeneration of the race as the eugenicists argued, has been shown to actually cause the opposite because in interracial marriages many autosomal recessive mutations are less likely to be expressed. For example, the marriage of a Caucasian and an African rarely results in sickle cell anemia or cystic fibrosis because expression of these genetic diseases requires two damaged genes, and a White is very unlikely to have the sickle cell anemia gene and a Black very unlikely to have a cystic fibrosis gene.[2] Likewise, blue eyes, rather than being an indication of a superior race, are now believed to result from mutations.[3]

A major theme of the book is the fact that decisions related to racism, law, and practice were not made by

Hitler or some Nazi politicians, but rather by a wide range of highly educated professionals including lawyers, biologists, geneticists, medical doctors, and academics. This fact was reflected in the conclusions of Austrian neurologist and psychiatrist, Holocaust survivor Viktor Frankl (figure 4):

> "If we present a man with a concept of man which is not true ... as a mere product of instinct, heredity and environment, we feed the nihilism to which modern man is, in any case, prone. I became acquainted with the last stage of that corruption in my second concentration camp, Auschwitz. The gas chambers of Auschwitz were the ultimate consequence of the theory that man is nothing but the product of heredity and environment—or as the Nazi liked to say, 'of Blood and Soil'. I am absolutely convinced that the gas chambers of Auschwitz, Treblinka, and Maidanek were ultimately prepared not in some Ministry or other in Berlin, but rather at the desks and lecture halls of nihilistic scientists and philosophers."[4]

The longest chapter in Whitman's book, chapter 2, titled "Protecting Nazi Blood", documents in detail the fact that the core of the Holocaust was the concern that inferior races would reproduce with the superior Aryan race,

Figure 4. Viktor Frankl

and consequently dilute the superior race, resulting in degeneration of the race. Called *Mischmasch* (a mishmash race mixing) or race defilement, the eugenicists taught that the penetration of Jewish blood into the German blood produced 'sick societies' that, in turn, themselves became degenerate (p. 74). The purpose "of the Nuremberg laws was to safeguard Germany from such degeneration, making it 'forever impossible for Jewdom to mix itself [*Vermischung*] with the German Volk'" (p. 74). This conclusion was based on the scientific consensus that existed both in Germany and the United States as well as much of the Western world. Hitler's infamous book *Mein Kampf* asserted that only "one drop of Negro blood placed in the veins of the purest Caucasian destroys the inventive genius of his mind and palsies his creative faculty" (p. 77). Criminalization of marriage is rare in legal history, and even Australia "did not follow American's menacing lead". Germany, though, did (p. 78). And thus:

> "… it is with the blood laws that we discover the most provocative influence of direct Nazi engagement with American legal models, and the most unsettling signs of direct influence. American law was expressly invoked in the key radical Nazi documents establishing the framework for the Blood Laws … . American models were championed by the most radical Nazi faction, the fiercest advocates of a stringent ban on sexual mixing" (pp. 76–77).

Unfortunately, these radicals prevailed and their framework eventually ended up in the Nuremberg blood laws that eventually led to the Holocaust. And the ultimate source of the race mixing belief was Darwinian eugenics, specifically American Darwinian Eugenics.

Ironically, the Nazis "found American law too harsh to be embraced by the Third Reich" and so attempted to take a much more humane approach in this area. This could be partly because in 1935 there were close to 550,000 full or three-quarter Jews, 200,000 half Jews, and 100,000 quarter Jews in Germany (p. 80). As a result, most existing mixed marriages were largely left alone. The goal was to prevent by law future mixed marriages, or at the least to encourage the Germans in existing mixed marriages to divorce the inferior race member (p. 85). The first step to reduce mixed marriages was an attempt to convince the German population by extensive propaganda that marriage to a Jew was 'sick'. (p. 75). When this approach failed, an attempt to exclude Jews from many areas of society was attempted. The American Jim Crow laws, which were the model Germany emulated, did not work with German Jews because, in contrast to American negroes, the Jews were generally very wealthy and well educated and, also, did not differ much in appearance from Aryans (p. 99).

Eventually, as Germany deteriorated, many persons with one Jewish parent lost their German citizenship and consequently faced increasing difficulties in Germany (p. 91). At this point, many left the country. Soon it was realized that what was required was a "clearly delineated and scientifically acceptable definition of who counted as a racial Jew" (p. 105). For this task, the esteemed scientists at leading German Universities were consulted to attempt to make these determinations scientifically.

Ghettoization was the next step in the road to the Holocaust, and next was confinement in concentration camps, and the last step was the 'final solution' or the total elimination of all inferior races, Jews first, then Slavic peoples, and eventually all races except Aryans.

Summary

This book carefully documents that the central foundation behind not only the Holocaust but the War itself was based on the goal to eventually eliminate all the inferior races to

give the superior Aryan race room to expand and eventually fill the earth. Thus, Darwinian Eugenics was a critical, but not the only, cause of the most destructive war in history in terms of lives and property lost. One Harvard study evaluated the 901 major wars that occurred between 500 BC and AD 1918, and concluded the number of combatants and casualties involved in World War II[5] made it 28 times more consequential than all wars before WW I put together.[6] One mistake in the book was that Whitman constantly referred to The National *Socialist* Workers Party as politically far right instead of its actual position, which is socialist, as in the name of the party, or politically left, as documented by *New York Times* bestselling author Dinesh D'Souza.[7]

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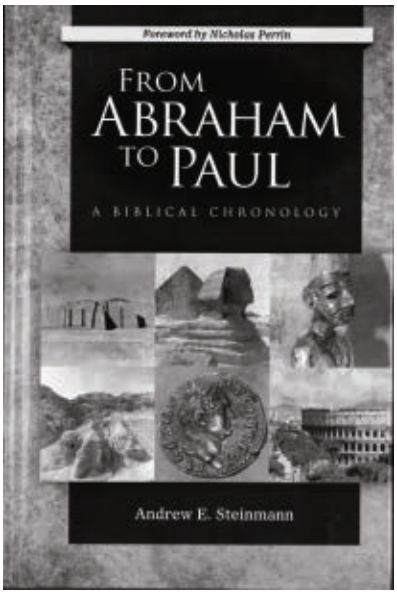
Unprecedented precision in biblical chronology

From Abraham to Paul: A biblical chronology

Andrew Steinmann

Concordia Publishing House, St. Louis, 2011



Brian Thomas

The academic book *From Abraham to Paul* supplies a precise and biblically responsible timeline that spans the millennia from Abraham to Paul. Its high view of Scripture treats extrabiblical chronological indications as secondary to the Bible's chronological data.

Before this book joined my library, I wallowed in shaded uncertainty borne from decades of living with the mantra, "the earth is 6,000–10,000 years old". I always wondered why, if God intended the year counts in Scripture to mean something close to what they appear from a straight reading (i.e. 'years'), do we need a 4,000 year-long fudge factor?

It appears that most chronological uncertainties that give rise to that factor antedate Abraham, and this book only traces back as far as that great patriarch. Author Andrew Steinmann pinpoints Abram's birth to 2166 BC. He also identifies Paul's martyrdom as between late AD 67 and early 68. The 350-or-so pages in between hash through the necessary details behind deriving those, and a few hundred other, dates for biblical events. Leaving cumbersome minutiae to the thoroughly referenced technical papers, or to footnotes on each page, the author imports enough information into the main text to step the reader through each logical interpretive and historical possibility throughout most of Scripture's chronology.

Andrew Steinmann is an Old Testament and Hebrew expert working at Concordia University, Chicago, at one of the ten Lutheran Church–Missouri Synod Concordia Universities in the United States. He is a biblical ('young earth') creationist.[1] The writing style he employs in *From Abraham to Paul* is necessarily and appropriately dry. It uses common terms so that readers like me who are not Bible chronologists can understand all the arguments presented. It avoids both sketchy outlines and painstaking pedantry, instead marching steadily through a few thousand years in a thorough yet readable manner.

Resolving questions of timing

The crowning feature of this work, which stands upon the efforts of centuries of prior Bible chronology studies, has to be its almost unerring settlement of virtually every chronological dilemma with a solution that fits the Bible exactly. In other words,

Figure 1. Steinmann's year-by-year timeline from Abram's birth to Paul's Journeys fills a long hallway.

at every point of chronological contention, Steinmann whittles down the interpretive options, discards first those that depart from the Bible the most, and resolves an answer that keeps Scripture's numbers *perfectly* intact.

Take, for example, the chronological kink in 1 Samuel 13:1. Steinmann wrote:

> "As for Saul's reign, as we have already seen, the text of 1 Sam 13:1 is corrupt, since the text as preserved credits Saul with an impossibly short reign of two years. However, Acts 13:21 and Josephus (Ant 6:378 [6.14.91]) indicate that Saul reigned 40 years" (p. 112).

He then adds a corroborating argument for those 40 years from Saul's youngest son, Eshbaal. Eshbaal was 40 years old when he began his rule. Verses like 1 Samuel 31:2 list Saul's three sons, and exclude Eshbaal. So this fourth son must have been born after Saul became king, and must have come to the throne about 40 years after his father did. In this way, Steinmann resolves the chronology while illustrating how to reconstruct the original text by cross-checking with overlapping data when one textual tradition (i.e. the Masoretic) has an issue.

Chronology dabblers (like me) will want to know if Steinmann offers a 'late date' or an 'early date' for the Exodus. He wrote, "God's speaking to Israel from Mount Sinai took place no earlier than 4 Sivan [a Jewish month that overlaps parts of May and June on the Gregorian calendar] 1446 BC." (p. 85). This 'early date' Exodus is the most bibliocentric option since it fits 1 Kings 6:1.

Plenty of conservative biblical archaeologists assert that the Exodus must be shifted forward a few hundred years to mesh with archaeological concerns like Pharaonic reign lengths. Steinmann skips all these discussions, content to stick like glue to the task of constructing a purely biblical timeline. Will the 200 or so year difference between what secular archaeology demands and what the Bible lays out somehow, some day, find reconciliation through the discovery that 'archaeology' did not demand the time shrinkage, but rather faulty human interpretations of the archaeological evidence did?

Steinmann supplies two possible pharaohs for the exodus: Thutmose III from the Low Chronology of Egypt, or Amenhotep II (of which there may have been two) from the High Chronology. Biblically, Israel departed Egypt on 14 Nisan (March–April) 1446 (Numbers 33:3).

Just enough details

At times the book's arguments get tedious, especially for the trickiest issues that require many pages of explanation. But, whether brief or extended, the arguments are laid out as plainly and openly as the subject permits. The author has a thorough enough comprehension of Bible chronology, a realm that has often seen arguments spiral *ad infinitum*, to know where and when to expand and explain verses or cut to the chase. One way Steinmann does this is to simply refer the reader to technical journal articles that already hash through the tough stuff. He often skillfully summarizes those papers' contributions.

And speaking of cutting to the chase, readers can opt to leapfrog tedium and easily extract dates for each listed event by accessing the many summary tables found throughout the text. The very expensive book comes with an online key that accesses the author's entire timeline for the reader to download. I printed it some years ago and pinned it to a hall wall where I work at the Institute for Creation Research so that our scholars could use it as a handy reference, and so visitors could see the numerical precision found in Scripture (figure 1).

When I reached the midpoint of the book, I began to consider the possibility that Scripture might record the exact and total number of years from Adam to Jesus—not merely a 6,000–10,000 year ballpark. When I finished the book, I thought that more biblical creationists should be aware of it, so I wrote a chronology paper that essentially worked from Steinmann's placement of Abram's birth at 2166 BC backward to the Flood using both the Masoretic text's numbers and the higher numbers that both the Samaritan Pentateuch and pre-Christian Septuagint copies recorded.[2] In that paper, I tried to condense Steinmann's already summarized historical evidences—mostly inscriptions—that pinpoint Babylon's destruction of Jerusalem to 587 BC. This anchors the Julian calendar onto the Bible's year counts going both backward and forward from that year. Then, by paying attention to Scripture's chronological details and clues, Steinmann and his community of chronologists were able to resolve finer historical details. For example, Judah's king Zedekiah was captured on the same day that Jerusalem's walls were breached after a long siege, on Saturday, 29 July 587 BC.

I now enjoy writing in the dates of various events into my personal study Bible. In that effort, I was quite pleased to discover the very handy appendices in *From Abraham to Paul* that list dates for specific verses. One appendix even lists years and, at some points, months and days for when certain prophets issued specific prophecies. An entrepreneur might do well in publishing a 'Historical Bible' with all of Steinmann's dates embedded on the appropriate pages, like early English Bibles used to show. Such a Bible would of course hold even more value with early Genesis events dated, but such must await scholars to sort through textual differences.

From Abraham to Paul earns high marks among conservative Bible chronologists for its novel assessment of New Testament events.[3] Author Steinmann ties together clues from biblical and extrabiblical sources—at points having to correct extrabiblical sources like Josephus on the weight of other overlapping evidence—to assess age ranges for many events in Acts. For example, he wrote:

> "Paul's first missionary journey must have ended with his return to Antioch sometime in AD 48. This is required by Luke's notice that Paul and Barnabas stayed in Antioch 'no little time' (Χρόνον οὐχ ὀλίγον; Acts14:28) before going to Jerusalem where the Jerusalem Council was held in early AD 49 (see the discussion beginning on page 320)" (p. 330).

The future of chronology

Why did the author begin his chronological timeline with Abraham's life and not prior events? As I discovered in the process of trying to extend this timeline backward, text-critical scholars have not yet settled on the original numbers for Genesis 5 and 11. Most creation scientists accept the Masoretic text, some because those are the numbers in English translations, and others for textual reasons.[4] Another view holds that the Genesis numbers in the earliest Septuagints, which match the Samaritan Pentateuch and pre-Christian Jewish writings but not Masoretic early Genesis numbers, preserve the original data.[5]

I heard that Steinmann is working on a Genesis commentary, and I know others are working on resolving textual differences. Hopefully, these kinds of labours will extend the Bible's timeline back from Abraham toward Adam. Overall, the data presented in *From Abraham to Paul* give renewed confidence in the historicity of the many chronologically marked Scriptural events, and thus more confidence in the accuracy of the totality of Scripture.

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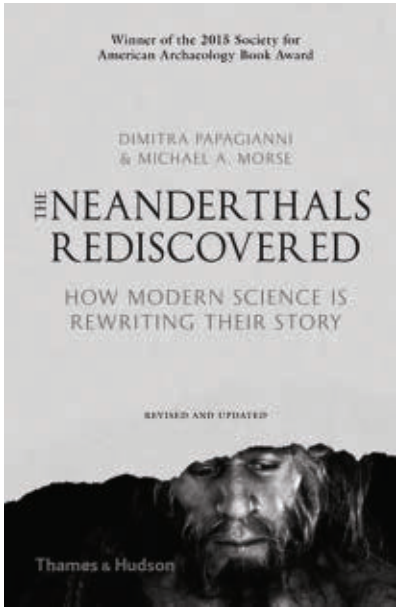
Modern science catches up with Neandertal man

The Neanderthals Rediscovered: How modern science is rewriting their story

Dimitra Papagianni and Michael A. Morse

Thames & Hudson Ltd, London, 2015



Jean O'Micks

Winner of the Society for American Archaeology Book Award in 2015, this seven-chapter book tells how the way Neandertals have been viewed by evolutionary anthropology has advanced since their discovery more than 150 years ago. Because of the interesting subject matter, discussed by a leading scientific association, a review of this book is well warranted. The book is 199 pages long, with 77 illustrations, 20 of them in colour. The book describes how the views of the Neandertals have changed, regarding their morphology, their geographical distribution, and, also, very interestingly, their behaviour and cognitive abilities.

The first chapter of the book starts with how the Neandertals were a type of human that has been long misunderstood. This is expanded upon in the last chapter of the book, which describes the popular, but false, imagery that Neandertals have in our society today. The Neandertals were first presented during the 1863 meeting of the British Association for the Advancement of Science at Newcastle-upon-Tyne. Professor William King of Queen's College, Galway, Ireland, was the name giver of this type of archaic human, based on the place where its first fossils were discovered, in Neander Valley in 1856 (named after the famous hymn writer Joachim Neander (1650–1680)).

Based on its thick bones, and a protruding crest above the eyes, the Neandertals were taken to be a species of humans halfway between chimpanzees and modern humans. Marcellin Boule (1861–1942) of the Museum of Natural History in Paris suggested that Neandertals walked with a stooped posture, based on a specimen from La Chapelle-aux-Saints, although later on it turned out that this specimen had arthritis and premature bone degeneration. Even *Homo erectus* was taken to be closer to modern humans because of its upright, erect posture. The Neandertal skull was much longer and flatter, with a protruding chin and stronger jawbones. The upper limit of the endocranial volume of Neandertals is up to 1,740 ml with a mass of 1.7 kg (p. 131).

The forerunners of the Neandertals

Chapters two and three describe the dispersal of other human species before the Neandertals, some of whom were their forerunners. The Neandertals themselves are supposed to have lived from 500,000 to 20,000 years ago, with the distinctive Neandertal form first appearing 250,000 years ago (p. 48, 73). Neandertals are known from several hundred fossil specimens all over the world. They ranged as far as Spain and western Asia, possibly even southern Siberia. At times, their geographical distribution overlapped with that of modern humans in some places. Noteworthy fossil sites of Neandertals and their close relatives in Europe and Israel are depicted in figure 1.

The first exit out of Africa supposedly took place 1.9 million years ago, but it is disputed as to which species left first, *Homo habilis* or *H. erectus* (p. 27). This was due to the climate in Africa becoming drier, forcing humans to change their diet from a plant-based one to one richer in meat. Here, the authors state that the evidence is so scattered that some anthropologists claim the genus *Homo* first evolved in Asia and back-migrated into Africa.[1]

Between 1 million and 600,000 years ago, the first members of the genus *Homo* appeared in southern Europe, such as in Atapuerca in Spain, and as far north as a site near Happisburgh (pronounced "HAYSbra") in Norfolk, England. The Atapuerca site had remains of two-horned rhinoceroses, hippopotamuses, bison, sabre-toothed cats, lynxes, bears, and hyenas—a very different fauna from that of today (p. 37).

What is peculiar is that the authors say that it took more than half a million years to reach these supposedly early southern European sites from Dmanisi, Georgia, in the Caucasus, which was

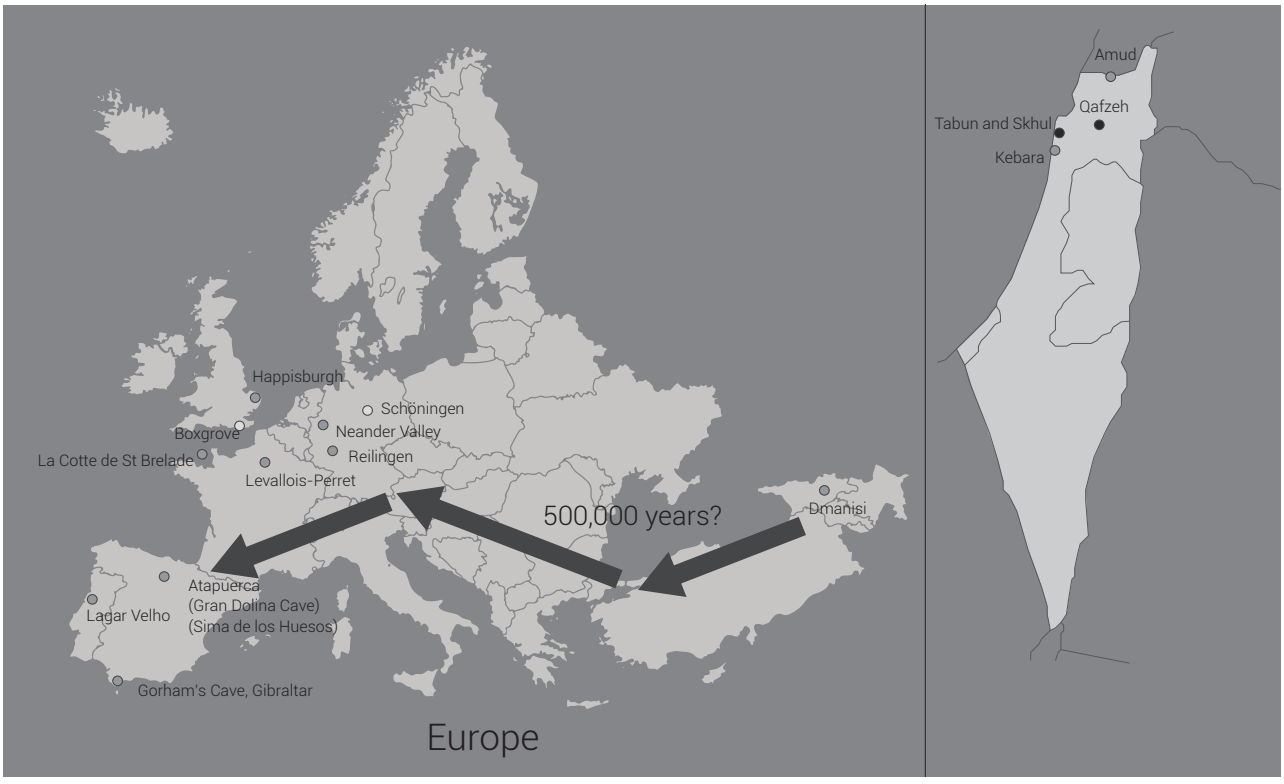


Figure 1. Fossil sites in Europe and Israel of different kinds of archaic and modern humans mentioned in this review. White (orange in illustration): *H. heidelbergensis*, grey (red in illustration): *H. sapiens neanderthalensis*, Black: modern humans.

initially occupied by humans, since the authors do not include the possibility that early humans crossed over the strait of Gibraltar, and that there was no land bridge at that time. Thus, it is presumed, without evidence, that there must be early human sites in central and Eastern Europe, waiting to be discovered.

The last common ancestor between Neandertals and modern humans was supposed to have lived at Gran Dolina Cave (at Atapuerca) (pp. 45–46), according to the authors, with prominent cheekbones and a brain larger than that of *H. erectus* (though not directly ancestral to Neandertals). However, the authors think the first Europeans represented an isolated migration out of Africa, and that they retreated out of Europe when the climate deteriorated. This is somewhat hard to believe, since, as stated previously, they first reached the southern and western extremities of Europe after 500,000 years (p. 32).

The ancestor to Neandertals is thought to be *Homo heidelbergensis*, extending from Africa and Europe right across to even India and China, 600,000 years ago. In 1985, remains of *H. heidelbergensis* were discovered at Boxgrove, in southern England, along with 300 hand axes and the butchered remains of elephants, rhinoceroses, horses, bison, and red deer (p. 52). Along with these artefacts, a shoulder blade of a horse was also discovered, showing signs of having been pierced by a spear. Similar spears embedded in horses were also found near Schöningen, Germany, dated from 340,000 years ago (p. 53). This indicates that *H. heidelbergensis* was a skilled hunter instead of a marginal scavenger, another sign that early humans had advanced cognitive capabilities.

Another important site near Atapuerca is that of Sima de los Huesos ('pit of bones' in Spanish), which contains 6,500 fossil remains from around thirty individuals, plus fossil remains of cave bears and other predators, such as lions, wolves, and foxes. Also found among these fossils was a red-coloured hand axe (p. 55–56). Sima de los Huesos is thought to be a burial ground. The fossils indicate that they were mostly right handed, which can be seen from their stronger right arms and legs, as well as the imprint of the shape of their brain inside the skull. Based on grooves left on their teeth, they also appear to have used toothpicks, indicating that they were aware of the necessity of dental hygiene (p. 57).

The Neandertals themselves

Chapters four to six of the book deal with the expansion of the Neandertals over the world, from an evolutionary age of 250,000 years ago to 25,000

years ago, when they supposedly disappeared. This period allegedly began when the endocranial volume of the Neandertals reached an average that was larger than that of humans living today. For example, a Neandertal skull found in 1978 in Reilingen, Germany, showed an endocranial volume of 1,430 ml, with an estimated weight of 1.36 kg, whereas the brain volume of *H. heidelbergensis* ranged between 1,100 and 1,350 ml, with an estimated weight of 1.05–1.28 kg (p. 77). Besides this, Neandertals had a prominent ridge above the eyes, broad noses, and large jaws, with no chin, as well as an occipital torus and a suprainaic fossa. Their teeth were also found to be worn down (p. 77–78).

Having such a large brain, even larger than that of modern humans, makes it hard to deny that Neandertals were intelligent. One of the main themes of the book is that it describes in detail certain areas of evidence which indicate that Neandertals had cognitive capabilities quite like those of modern humans.

For example, a pile of concentrated mammoth and rhinoceros bones was found underneath a cliff overhang at La Cotte de St Brelade on what is now the island of Jersey, but was then a peninsula of Normandy. Researchers speculate that this could have been the end of a 'drive lane', similar to what some American Indians use when funnelling their prey in the direction of, and over, a cliff. These Indians plan a route in which they drive their prey, bursting forth at certain strategic points to keep the animals moving. Such evidence indicates that Neandertals could have been capable of forward planning, whereby they choreographed their moves when hunting animals (p. 80–81).

Many primate and bird species are capable of using simple tools for certain purposes, but higher intelligence is manifested in the way in which Neandertals used special tools to make other kinds of tools. Such tool-making tools were used to strike flakes off of a stone core, flake by flake, until a sharp edge was produced, which could be used as a spear tip. The French archaeologist François Bordes (aka Francis Carsac, 1919–1981) classified Neandertal tools into 63 tool types, 21 of which were a variety of 'side scrapers', which consisted of long blades or flakes which had been continuously retouched (p. 96). Furthermore, there is recent evidence that Neandertals used pendants, pigments, and adhesives to form composite tools (p. 155).

A larger brain implies a greater neocortex size, which was necessary for socialization. Neandertals could have possibly hunted in groups. The fact that their remains were found in caves suggests that they led social lives, which in turn also implied that they used language to communicate with each other. Language is supposed to have arisen at a suprisingly early evolutionary age of some 500,000 years ago (p. 101), or even earlier, with *H. heidelbergensis*. Neandertal remains found in 1982 at Kebara, Israel, dated to 60,000 years ago, included a modern-looking hyoid bone, which is an essential component of vocal architecture (p. 115). Neandertals also had a copy of the FOXP2 gene in their genome (p. 170), with a sequence that is exactly the same as that of modern humans, which is necessary for the fine motor skills, coordination, and executive function needed for producing a large variety of sounds during speech. Mutations in the FOXP2 gene lead to motor-related speech problems.[2]

One of the areas where Neandertals and modern humans mixed was in the Middle East, based on fossils and what strongly appear to be burial sites in Israel, such as Qafzeh and Skhul, where modern humans were buried, with an evolutionary age of 90–135,000 years. Neandertal remains from Amud and Kebara, Israel, were were shown to have an evolutionary age of only 50–60,000 years ago. In fact, the supposedly last living Neandertal, dated at 20,000 years old, came from Tabun, Israel. These dates overturn the idea that modern humans came later than Neandertals whom they conquered.

Another characteristic of both modern humans and Neandertals is what kind of shelter they used, and how they cared for their dead. As mentioned, Neandertal remains have been found inside caves; this would indicate a desire to preserve the remains of the deceased, as compared to that of animals, who merely leave their dead out in the open. The cave at Atapuerca is not necessarily an example of intentional burial, since the remains were not buried in a grave, but were deposited down a long shaft. However, recently, a number of Neandertal burial sites have been discovered, accompanied by ornamentation, usage of pigments, and intentional burial with grave goods.[3]

Blombos Cave, in South Africa, contains artefacts dated to an evolutionary age of 100,000 years, in the form of ornaments, such as mollusk shell beads, fishing paraphernalia, and items used in stone tool manufacture. Other ornaments include bird talons. What is interesting is the presence of red ochre in this cave, as well as what appeared to be a painting tool kit, and a processing workshop. Red ochre painting was also discovered in a cave in Gibraltar in a crosshatch fashion, the first Neandertal 'hashtag'. Shanidar Cave in Iraq contained remains of ten Neandertals, one of which displayed signs of partially healed wounds caused by some sort of trauma. Another Neandertal individual had been intentionally buried, and the grave covered by ornamental flowers. Thus, art and ornamentation could have also been part of Neandertal culture and society.

The decline and disappearance of the Neandertals

The authors describe the decline of the Neandertal period broken down to three time periods. These time periods are said to have spanned an evolutionary age of 60,000 to 45,000 years ago, when the Neandertals expanded their range during a mild, yet variable, interglacial period. Geographically, Neandertals had also extended into western Asia, and even into southern Siberia. Many researchers qualify the Denisovans, a species known solely from its DNA, as a closely related sister group of the Neandertals.[4] The second period was allegedly from 45,000 to 37,000 years ago, when modern humans arrived in Europe, and our range overlapped with that of Neandertals. The last period is said to have been from 37,000 to 25,000 years ago, with the spread of the so-called Gravettian culture, showing an influx of new kinds of people (pp. 133–136).

Previously, the Aurignacian tool industry, which itself had replaced the characteristically Neandertal Mousterian industry, had included improved blade production using soft-hammer percussion, and more sophisticated stone tools with blades, which had also involved expanded trade networks, implying that different Neandertal populations kept in contact with each other.

There are more signs indicating the higher intelligence of Neandertals from these time periods. Phytoliths, starch granules, and proteins from Neandertal dental calculus indicates that they consumed plants, such as pine nuts, forest moss, poplar bark; mushrooms such as split gill; as well as plant fungal pathogens.[5] Edible grass seeds, charred legumes, and nuts were found at caves in Israel and Gibraltar (Gorham's Cave).[6] Poplar contains the natural pain-killer salicylic acid, indicating knowledge of medicinal plants and some knowledge of plant taxonomy.[6]

Genetic interbreeding between modern humans and Neandertals caused certain genes to intermix between these two types of humans (p. 177). Modern humans are held by some evolutionary geneticists, such as Svante Pääbo from the Max Planck Institute for EvolutionarAnthropology to have received genes from Neandertals, such as those involved in the immune system, which possibly protected against some illnesses, as well as genes which heighten the risk for type 2 diabetes, as well as genes which influence hair and skin colour.[7]

Interpretation of the book from a creationist perspective

According to the well-known saying, if it looks like a duck, swims like a duck, and quacks like a duck, then it most likely is a duck. Basically, if an archaic form of human displays so many signs of social, cognitive, and cultural abilities and characteristics that are shared with humans, then this is strong evidence that it is also human, a member of the human holobaramin. Table 1 lists 19 such characteristics, all described in the book as being shared by Neandertals and humans. Such marks of higher intelligence include the making and usage of over sixty different kinds of tools, burial of the dead, language, symbolism, and complex hunting patterns, and possible use of snares.[8]

The authors separate Neandertals from modern humans based on their special morphological characteristics, despite the fact that they were able to reproduce together, as evidenced by 1–4% of DNA present in the genomes

Table 1. Cognitive characteristics shared by Neandertals and modern humans mentioned in the book

Characteristic	Note
Burial of dead (p. 105)	
Cared for the disabled (p. 149)	
Used medicinal plants (p. 152)	Implies knowledge of plant taxonomy
Dental hygiene (p. 57)	Use of toothpicks
Complex hunting pattern of large animals (p. 81)	
Spoken language (p. 101)	
Created art and decoration (p. 154)	Usage of symbolism, abstract thought
Harvested sea food (p. 13)	Marine navigation
Used clothing and fire (p. 178)	
Created and used sixty-three types of tools (p. 96)	
Usage of tools to create other tools (p. 88)	
Creation of composite tools (p. 155)	
Trade networks (p. 156)	
Majority right-handedness (p. 148)	
Repetitive muscle actions (p. 148)	
Music (p. 155)	Use of flutes
Cannibalism (p. 39)	
Quasi-global geographical distribution (p. 129)	
Survival in harsh climates (p. 178)	

of modern humans.[9] Furthermore, there is evidence from fossils of individuals showing mixed characteristics between Neandertals and modern humans. One such example is that of a four-year-old child buried with pierced shells and red ochre in Abrigo do Lagar Velho. Dental proportions, certain mandibular characteristics, diaphyseal curvature, and pubic proportions align with those of modern humans, whereas femorotibial lengths and diaphyseal robusticity suggest that it is Neandertal.[10] Another example of a recently found fossil hominin showing mixed characters is a set of skull remains from Jebel Irhoud, Morocco, dated to an evolutionary age of 315,000 years.[11] Neandertal characters include an elongated braincase. However, most of the facial characteristics resemble those of modern humans, such as a relatively short and retracted face, weak brow ridges, as well as the reduced dentition resembling that of early modern humans.[12]

Furthermore, many creationist studies have indicated that Neandertals and modern humans belong to the same holobaramin, based on both cranial and post-cranial characteristics.[13] Modern humans, Neandertals, and their direct ancestors display lower genetic diversity than the great apes, indicating that they have undergone a demographic bottleneck in the recent past,[14,15] similar to modern humans. This means that humans could have been morphologically diverse before this demographic bottleneck, which could correspond to the dispersion after Babel, since at this time humanity broke up into smaller people groups. Furthermore, there are some human fossils showing mixed characteristics from both modern humans and Neandertals.[10] This means that these two groups interbred with each other, so were members of the same created kind, and that their individual genetic characteristics influenced the hybrid morphology of their offspring.

What is quite anomalous about the Neandertals is their geographic distribution. The remains of both Neandertals and modern humans (as well as erectines and *H. heidelbergensis*) have both been found in Europe and Asia, which is a quasi-global distribution. Neandertal remains have also been found in Africa.[16] Some researchers even believe that the Denisovans showed signs of genetic admixture into 33 populations from southeast Asia and Oceania[17]. The assertion that the authors make, that it took 500,000 years for Neandertals to reach Spain from Dmanisi in the Caucasians, can be measured based on modern history. It is known, for example, the seven Hungarian tribes came into the Carpathian Basin from the ancient homeland, Magna Hungaria (an area of land north of the Caspian Sea) within only several hundred years, which is roughly half the distance between Dmanisi and northern Spain, where Neandertal remains were found.

In summary, we can conclude that with scientific advances made in anthropology and with more and more recent discoveries made over the past 150 years, the way Neandertals have been viewed according to evolution has changed dramatically. There are some variations in morphology, quite possibly due to a higher pre-Flood variation. But instead of primitive, brutish animals, half-way between animals and humans, we can state with high enough confidence that Neandertals are the same species as modern humans, and part of the human holobaramin.

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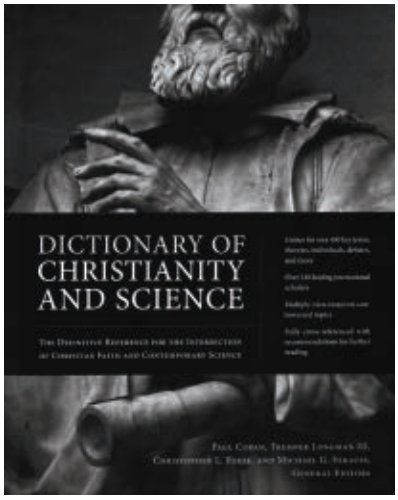
Important reference work offers good overview of interpretive options

Dictionary of Christianity and Science: The definitive reference for the intersection of Christian faith and contemporary science

Paul Copan, Tremper Longman III, Christopher L. Reese, Michael Strauss (Editors)

Zondervan, Grand Rapids, MI, 2017



Lita Cosner

With a slightly self-congratulatory name, the *Dictionary of Christianity and Science* claims to be 'the definitive reference for the intersection of Christian faith and contemporary science' in its subtitle. The book is hardback, but has a glued binding that does not look like it would survive heavy use.

Given that Zondervan is a mainstream publisher not known for being overly conservative, the book does a surprisingly good job in offering a good overview of the various interpretive positions in certain areas.

Format

The *Dictionary of Christianity and Science* features short articles on people and subjects that are relevant to the discussion of Christianity and Science. This includes people from church history and the founders of various types of science, modern figures in the religion/science discussion, scientific concepts such as 'natural selection', and theological concepts such as 'resurrection'.

Some particularly controversial topics feature multiple articles by authors from various viewpoints. For instance, the 'first couple' view of Adam and Eve is presented by Todd Beale, who holds that view (p. 19ff), and the 'representative couple' view of Adam and Eve is presented by Tremper Longman, who holds that view (p. 23ff). While the depth of the discussion is limited by the constraints of the format, the condensed overviews are a helpful starting point, and each article contains references and recommended reading for those who wish to go further.

One weakness of this format is that it makes the various options seem equally viable from a biblical point of view, when this is clearly not the case. So, while it is a helpful starting point, discernment is needed (as with all such resources). But it is refreshing to see an attempt to fairly represent creationists without caricaturing the viewpoint as literalistic and antiscience.

Dictionary entries on 'Days of Creation'

It is obviously impossible to give a thorough review of every relevant entry in such a large volume, but the three entries on 'Days of Creation' are a good representative example. The first entry is 'Days of Creation (24-hour day view)' which argues, "the predominant view until recently has been that the creation days were 24 hours" (p. 158). It critiques the Day–Age view and Framework Hypothesis.

The second entry, on the Day–Age view, argues that the creation days were "six long but finite time periods" (p. 162). Most young-earth creationists would be aware of the arguments put forward in the entry, including that "the events of day 6 require a long time" (p. 162), "God's days need not be the same as our days" (p. 163), and "Bloodshed before Adam's sin does not alter the atonement doctrine" (p. 163).

The 'Framework Hypothesis' entry argues that when Scripture is interpreted within its literary and cultural context it becomes clear that a literalistic interpretation is not what was intended. It argues "The New Testament writers did not interpret Genesis, let alone read it, 'literally'. They treated its stories archetypically and symbolically, as illustrations to help explain Jesus and the Gospel" (p. 165). It goes on to interpret what happened during the six days of creation.

While the last two entries contain much that biblical creationists would disagree with, having the three entries, written by adherents to the various views, is useful.

Elements to appreciate

It shows integrity that the compromising editors invited young-earth creationists to write regarding their views, including Todd Beale, Marcus Ross, and others. This means that there are good biblical creationist articles on

the Genesis Flood (pp. 305–309) and other topics. Even when evolutionists are writing on topics where creationists would disagree, for instance Darrel R. Falk writing about *Archaeopteryx*, there is an effort to accurately represent the belief of biblical creationists with minimal polemic (pp. 46–47). Significantly, the different views are usually given equal amounts of space.

The *Dictionary* also helps to dispel some common myths regarding Christianity's interaction with science. For instance, the article on Giordano Bruno (p. 75–76) dispels the myth that he was burned for being a Copernican, and correctly states that he was executed for his heretical philosophy as "Bruno's books provided ample evidence of heterodoxy for the inquisition to pick over" (p. 76).

Elements that could have been better

Above I noted that the editors did a creditable job to make sure that biblical creationists and other views were adequately represented, including having them author articles about young-earth creationism. But this ends up being incomplete, because articles on scientific concepts like the Cambrian Explosion (pp. 78–79) are authored by evolutionists, while creationists would have a significantly different view. In other words, creationists have a different interpretation of the scientific facts, not just the biblical concepts where they were invited to contribute. And even where the author attempts to be fair to opponents of evolution, sometimes the presentation of the creationist view is simplistic (though this could also be an effect of length restrictions), as in the article on evolution and probability (pp. 243–245).

Notable places where creationists were not given an article include the problem of evil section (where theistic evolutionists and progressive creationists were given articles, pp. 220–226). Also, while there was a uniformitarianism article by a uniformitarian geologist, there was not a corresponding catastrophism entry.

Odd decisions

There are a few places where the Dictionary makes odd choices regarding what to cover or what position to take on a subject. The article on extraterrestrial life, for example, is vaguely optimistic about the eventual discovery of life on other planets, and argues, "the thesis that humans have a central place in God's plan for earth history does not imply that humans have a central place in God's plan for *cosmic* history" (p. 269).

Given this perspective on extraterrestrial life, it is unsurprising that it takes a similar positive stance on panspermia, saying that it is a 'viable theory' and that "the fossil record and the appearance of novel DNA on Earth throughout its history could arguably be due to contamination from meteoritic cyanobacteria rather than DE [Darwinian evolution]" (p. 503). This article is useful in that it illustrates the lengths to which one will go to avoid accepting the biblical account of creation, and that it has nothing to do with following the scientific evidence.

Given the absence of any other articles on medieval relics, the inclusion of the one on the Shroud of Turin is odd, especially given the absolute lack of any sort of skepticism about its authenticity. Gary Habermas notes that the wounds represented on the Shroud bear striking resemblance to Christ's, and that early images of Christ bear resemblance to the image on the Shroud (p. 630). However, even the most incompetent forger would make an effort for his forgery to bear resemblance to Christ's popularly accepted likeness and for the wounds to match up with the biblical account. Given the evidence for a possible method of producing the Shroud image with medieval technology, it is shocking that the authors of the article judged its readers as being so gullible.

Gary Habermas also contributed the entry on 'near-death experiences', and once again showed a lack of discernment in his interaction with this phenomenon. He claims that it is a powerful argument against naturalism and "may provide pastoral or other practical considerations regarding at least the existence of life after death" (p. 475). He also says:

> "Near-death experiences certainly raise some difficult questions for believers. Most people who have NDEs report chiefly positive experiences, even if they are atheists or members of another religion. Moreover, the common interpretation drawn by many seems to be some sort of syncretistic universalism, with all religions providing ways to God. Occultic connections also emerge here and there. If NDEs are well evidenced, what should be concluded concerning these various conundrums?" (p. 475).

These are really good questions to ask; unfortunately, he does not answer them. Rather, he says that we should focus on the parts of NDEs that can be verified, such as people recounting what happened to them when there was no heartbeat or measurable brain activity.

A useful resource to be used with discernment

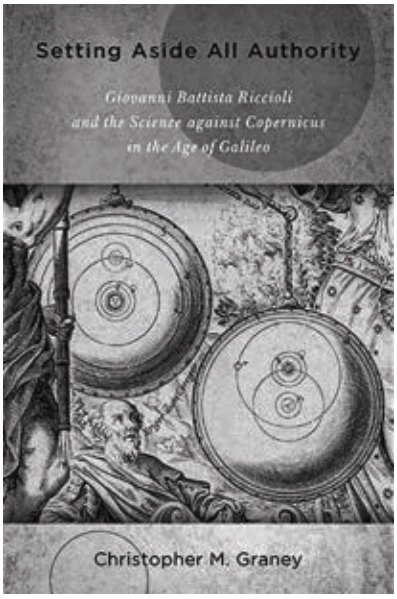
There are many elements to appreciate about the *Dictionary of Christianity and Science*, even though there are some questionable elements which require it to be used with discernment. It will doubtless become a standard introductory resource on the topic.

The Copernican debate: science vs science not science vs religion

Setting Aside All Authority: Giovanni Battista Riccioli and the science against Copernicus in the Age of Galileo

Christopher M. Graney

University of Notre Dame, 2015



John G. Hartnett

The book comprises 10 chapters, 270 pages. The last half of the book largely consists of two appendices: (a) the first English translation of Monsignor Francesco Ingoli's essay to Galileo (disputing the Copernican system on the eve of the Inquisition's condemnation of it in 1616) and (b) excerpts from the Italian Jesuit astronomer Giovanni Battista Riccioli's reports on his experiments with falling bodies.

It is interesting to note that the cover of the book is taken from Riccioli's *New Almagest* (1651), and it depicts both the heliocentric system (top left) with the Tychonic hybrid geocentric system (bottom right).

Most people think that around the time of Galileo, and the beginning of the Copernican revolution, opponents of the heliocentric worldview were primarily motivated by religion or dictates from the authority of the Roman Catholic Church. However, this book demonstrates that this is oversimplified and mistaken.

The author, Christopher M. Graney, uses newly translated works by anti-Copernican writers of the time to demonstrate that they predominantly used scientific arguments and not religion in their opposition to the Copernican geokinetic system. Graney argues that it was largely a science-versus-science debate, rather than church-versus-science as often incorrectly portrayed.

In 1651, the Jesuit Giovanni Battista Riccioli published his book *New Almagest* wherein he outlined 77 arguments against the Copernican system and 49 arguments in favour of it. Most arguments against the Copernican system could be answered, at that time, but Riccioli, using the then available telescopic 'observations' of the size of stars, was able to construct a powerful scientific argument that the pro-Copernican astronomers could not answer without an appeal to the greatness of God.

Graney largely uses Riccioli's *New Almagest,* which argues in favour not of the Ptolemaic system but of the hybrid Tychonic system, where Earth is immobile at the centre of the universe, the sun, the moon, and stars circle Earth; but the planets circle the sun. Riccioli built on the work of Danish astronomer Tycho Brahe, and built a strong scientific case against the heliocentric system, at least through the middle of the seventeenth century, which was several decades after the advent of the telescope.

The main two arguments presented in the book, both scientific, are the *size of stars* and the effect on *falling bodies*.

Falling bodies

If Earth were rotating, then a falling body should hit a point on the surface of Earth at a definite distance from a vertical line to the surface, if dropped vertically. The same argument could be made for cannon balls fired in different directions on Earth's surface. These types of discussions and arguments carried on for a century, and even Isaac Newton got involved. What we now know as the Coriolis force, a 'fictitious' force, resulting from the rotation of the planet on the fired or dropped objects could not be measured with the required precision in the 17th century. Riccioli carried out many precise ball dropping experiments. He intended to show that there was no deviation in the path of the falling bodies but he failed to get any conclusive result (due to many unknown and uncorrected errors). Also he had argued that experts firing cannon balls would have to correct for Earth rotation (if Earth did rotate). However, it was found that the 'experts' were nowhere that good, they did not have that sort of precision or accuracy, and so that also was an inconclusive argument.

We know today that the rotation of Earth has to be taken into account for long-range military targeting of projectiles (due to the Coriolis force). Even highly accurate snipers firing over 1,000 m are required to account for not only wind direction, wind speed, air density, and elevation, but

Figure 1. Foucault's pendulum in the Panthéon, Paris

also the Coriolis effect due to the rotation of Earth.

In 1851, 200 years after Riccioli's publication of *New Almagest,* Léon Foucault first demonstrated his pendulum in Paris. It was the first accurate demonstration of the effect of Earth rotation on falling bodies. The pendulum (figure 1) swings with a regular period and as Earth rotates the path of the pendulum successively moves to the left (as viewed from above) tracing out a circle. This is the effect of the Coriolis force and proof of the rotation of the planet.

Interestingly, the argument used by Galileo and other pro-Copernicans was that no effect on falling bodies could be detected due to *common motion*. Galileo used an analogy about an insect flying inside of a moving ship at sea. But Foucault's pendulum proves that analogy to be invalid.

Sizes of stars

The size of stars argument went as follows. Sizes of stars were first measured by eye, before the invention of the telescope. That is what Tycho Brahe spent much of his time doing. That gives a 'magnitude' for a star, catalogued as magnitudes 1 through 6, with 1 the largest and 6 the smallest. Of course, large meant bright and small meant dim. It was based on these 'measured' sizes of stars that Tycho Brahe developed an argument against Copernicus. (Even before Brahe, Johannes de Sacrobosco's *De sphaera mundi* (*On the Sphere of the World*, c. 1230), the standard university astronomy textbook for medieval universities and seminaries, taught:

> "Also Alfraganus [9th century Muslim astronomer] says that the least of the fixed stars which we can see is larger than the whole earth. But that star, compared with the firmament, is a mere point. Much more so is the earth, which is smaller than it."[1]

Then with the invention of the telescope, it was observed that the star sizes were at least 10 times smaller. But because the astronomers also observed solid disks for the planets out to Saturn (and even phases for Venus) it was then believed that the telescope gave the true sizes of the stars also. Based on telescopic measurements of the star sizes, Riccioli formulated a version of the Brahe argument against the heliocentric system and in favour of the geocentric Tychonic system.

This is another irony: the popular myth goes that Galileo presented his telescope to the geocentrists, and they refused to look through it. Actually, as science historian James Hannam pointed out:

> "So who refused to look through Galileo's telescope? According to the historical record, no one did for certain. The argument was over what they could see once they did look."[2]

And Graney shows that Galileo's critics did he allegedly asked, and used their observations against him.

With the telescope, astronomers looked for parallax of the distant stars but were not able to detect any parallax. In the geocentric universe, Earth is immobile and hence no parallax would be expected. In the heliocentric universe, Earth orbits the sun once per year, and in so doing, over a six-month period it moves from one side of its orbit to the other. Therefore based on trigonometry, a foreground star should be seen to move against the more distant background stars between these two extrema. But of course the orbit is circular. Therefore if a star is close enough it should trace out a circle on the sky as seen from Earth over the solar year.

Thus the argument followed: if a star was seen to have a certain size but it was too distant to exhibit any parallax, then it must be massively large, at least as large as the orbit of Earth around the sun. It was argued that that must be the case, otherwise no disk for the star could be observed. The only response the Copernican astronomers had to that was that God is a great God and He made such large stars for His own glory. Riccioli argued that it was not the geocentrists who appealed to authority but the heliocentrists, in their answer to the 'size of stars' argument—purely a scientific argument based on the best science of their day.

Graney points out that another who made that argument was Johann Geog Lochner in his book *Mathematical Disquisitions Concerning Astronomical Controversies and Novelties* (1614).[3] And the leading Polish mathematician, Peter Crüger, likewise thought this was an almost watertight argument against the geokinetic view.[3]

The *real* size of stars

Ironically, the geocentrists may not have made their own error (assuming the telescopes gave the correct size of stellar disks) had they been privy to English astronomer Horrocks' report on the 1639 transit of Venus across the sun. During his observations, Horrocks noted that he observed the moon passing through the stars of the constellation Pleiades. As the leading dark edge of the moon passed in front of the stars they simply winked out. They *vanished suddenly*, meaning they did not transition to darkness as you might expect if their disk was being slowly covered by the dark edge of the moon. This meant that the 'measured' size of the stellar disks was in fact

spurious—due to a cause unknown at the time. The sizes of the planets were correct because the telescope resolution was sufficient but it was not sufficient for distant stars.

But Horrocks' report was not published until 1662, 11 years after Riccioli published his *New Almagest.* And in 1659 Christian Huygens published his observations of stars using filtering (with smoked glass) wherein he showed the star sizes changed with greater filtering. Thus, it was soon realised that stars were actually point objects. In 1665 Riccioli published his *Reformed Astronomy*, in which he maintained his table of star sizes but de-emphasized the star-size argument.

Of course, if the stars are so enormously distant and if their 'measured' sizes are spurious, then the major scientific argument the geocentricists had against the heliocentrists evaporates. By 1720 Edmund Halley argued that the star sizes were spurious, but some astronomers still maintained the argument. A century later English astronomer George Airy developed a full theoretical explanation for the spurious disk of stars. It explained both the appearance of disks and why they varied in size for different stars. This effect is known as an 'Airy disk' and results from diffraction effects in the objective lens of the telescope. Because light has a wave nature adjacent beams interfere with each other, creating a pattern of maxima and minima. Since the lens is circular it produces a central bright maximum surrounded by ever-reducing surrounding rings (see figure 2). The same effect would be observed with the human eye[4] (i.e. a lens) or a pinhole (i.e. no lens).

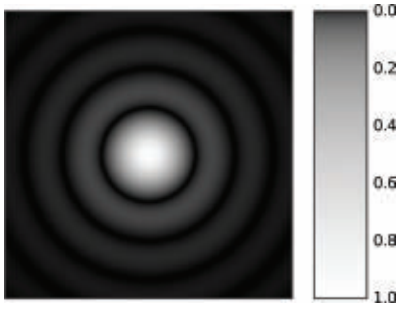


Figure 2. Computer-generated image of an Airy disk. The greyscale intensities have been adjusted to enhance the brightness of the outer rings of the Airy pattern.

However, Galileo didn't know about Horrocks' report that demonstrated that the stars were really pinpoints as seen from Earth. So instead, he claimed that with a good telescope and looking at a star through a thin beam, one could observe the apparent motion of the star's disk split by the beam. But there is no disk to split except that produced by the telescope—so Galileo just could not have seen what he claimed. As Graney says:

> "So, if the telescopic disk of a star does not exist outside the telescope, and if it cannot be cut in half by some beam placed between the telescope and the star, then Galileo's reference to cutting a star disk as 'an effect which can be discerned perfectly by means of a fine telescope' is strange indeed. It seems Galileo just made that up. In science, it is not cool to just make things up!" [5]

Conclusion

Thus Graney argues that it was not until the mid-19th century before complete arguments supporting the Copernican system were developed to refute Riccioli's arguments. This means that Galileo hadn't really proved the geokinetic system given the knowledge *available at the time*.

The main two arguments were the size of stars, explained by their spurious observed disks, and the lack of precision of falling body experiments, after which it was shown via the Foucault pendulum that Earth does in fact move, rotating in its axis.[6] Thus Graney argues that the old canard that astronomers of the 17th century held onto religion and authority as their argument against Galileo and the Copernican system is wrong. It was science against science and not science against religion *per se*. Both sides at times used religion but the 'battle' was primarily fought with science.

References

1. The Sphere of Sacrobosco: An early 13th century treatise on astronomy, by Iohannes de Sacrobosco, ch. 1, trans Lynn Thorndike, 1949, esotericarchives.com.
2. Hannam, J., Who refused to look through Galileo's telescope? bedejournal.blogspot.com, 20 November 2006.
3. Graney, C., Galileo fought dirty with his fellow scientists: the Italian astronomer had critics inside and outside the Church, theatlantic.com, 17 October 2016.
4. This is what originally led Tycho Brahe to establish different sizes (magnitudes) for stars, which, as already stated, turned out to be spurious. The lens in the human eye produces an Airy disk when observing a star with the naked eye.
5. Graney, C., Strange tales of Galileo and proving: splitting the stars, vofoundation.org, 26 April 2017.
6. It is true that the modern-day geocentrists do not accept that interpretation of the path of Foucault's pendulum, during the diurnal cycle. But I would venture to say that they would not accept any scientific evidence in support of the geokinetic system.

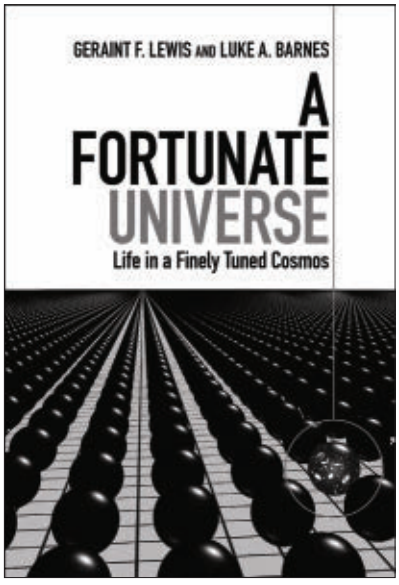
A naturalist's nightmare

A Fortunate Universe: Life in a finely tuned cosmos

Geraint F. Lewis and Luke A. Barnes

Cambridge University Press, UK, 2016

Dominic Statham



> "We are such insignificant creatures on a minor planet of a very average star in the outer suburb of one of a hundred billion galaxies. So it is difficult to believe in a God that would care about us or even notice our existence" (Professor Stephen Hawking, FRS, cosmologist).[1]
>
> "... humanity appears to be part of a remarkable set of circumstances involving a special time around a special planet, which orbits a special star, all within a specially constructed Universe" (Professor Brian Schmidt, astrophysicist and Nobel Prizewinner (foreword, p. xii)).

This is a remarkable book, full of helpful information for those seeking to understand the extent to which our universe is finely tuned for life. The authors are well qualified to write on the subject. Geraint Lewis is Professor of Astrophysics at the Sydney Institute for Astronomy and Luke Barnes has a Ph.D. in astronomy from Cambridge University in the UK. Some of the material is hard going for the non-specialist and can be very detailed and longwinded. However, there is still much that can be grasped by those who have a basic understanding of chemistry and physics.

Unfortunately, and despite its many problems,[2] the authors unquestioningly accept big bang theory as the explanation for the universe. Consequently, the reader must make a conscious effort to distinguish between the fine-tuning needed for life generally, and that required to support the big bang. To avoid confusion in this review, care has been taken to separate the two issues, the general case being addressed first and big bang fine-tuning second. In both cases, however, the fine-tuning arguments are those of Lewis and Barnes, not the reviewer.

Masses of fundamental particles

Atoms are made up of a nucleus with electrons in orbit around it. The nucleus contains protons and neutrons which, in turn, are made up of quarks—'up quarks' and 'down quarks'. A proton comprises two up quarks and one down quark, and a neutron two down quarks and one up quark.

The masses of the quarks must be just right to sustain life (pp. 48–53). Neutrons are slightly heavier than protons, so a lone neutron will decay into a proton + electron + antineutrino in a mean lifetime of about 15 minutes. In the nucleus, they are stabilized by the strong nuclear force. But if the mass of the down quark were increased by a factor of three, neutrons would decay even in a nucleus, leaving a universe containing only hydrogen, i.e. one dominated by protons.

Decrease the mass of the down quark by merely 8%, and protons in atoms will capture the electrons in orbit around them, leaving a universe dominated by neutrons. Increasing the mass of the electron would cause protons and electrons to spontaneously form neutrons, also leading to a neutron universe. In both proton-dominated and neutron-dominated universes we can say goodbye to the periodic table and, with it, the possibility of the molecules needed to support any lifeform.

The fine-tuning requirements associated with the masses of these fundamental particles are illustrated graphically in figure 1 where the small grey region shows the conditions required for chemistry to operate and the molecules needed for life. Its smallness, however, is not illustrated very clearly. The axes could legitimately be extended so that the white (representing sterile universes) covers many square kilometres, showing the grey area to be miniscule in comparison (pp. 52, 53).

Magnitudes of fundamental forces

In our universe there are four fundamental forces:

- gravity force
- electromagnetic force
- strong nuclear force
- weak nuclear force

While gravity and electromagnetism are easily observed, the strong and weak nuclear forces are more esoteric, operating within the very centres of atoms. The force due to gravity results in the attraction of matter to itself. Electromagnetic forces cause

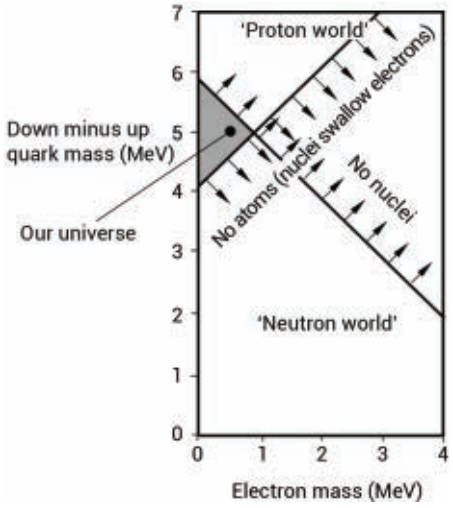


Figure 1. Graph showing the fine-tuning required of the masses of fundamental particles (i.e. up quarks, down quarks, and electrons). Values above the line with the negative gradient and values below the line with the positive gradient lead to sterile universes where no chemistry can occur. The small grey triangle shows the conditions required for a life-sustaining universe and the black dot represents values for our universe. The axes could legitimately be extended so that the white area covers many square kilometres. (After Lewis and Barnes, figure 12, p. 52.)

electrically charged particles to attract or repel one another, with like charges repelling and unlike charges attracting. It is this force that holds negatively charged electrons in orbit around their positively charged atomic nuclei. The strong nuclear force binds quarks together to form protons and neutrons. It also holds the atomic nucleus together, overcoming the tendency of the positively charged protons to push one another apart. The weak nuclear force is involved in radioactive beta decay and nuclear fusion.

The strong nuclear force needs to be strong in order to maintain the general stability of matter. For example, as the strong force is reduced, more and more elements become radioactive (due to alpha decay); and as protons and neutrons become free to escape from their nuclei, one kind of element will turn into another! However, if the strong nuclear force were just a little stronger, it would bind the diproton (i.e. cause two protons to stick together) leading to stellar instability—and our sun would burn through the entirety of its fuel in about a second. If it were just a little weaker, deuterium would unbind (i.e. fall apart), preventing the first nuclear reaction step in the sun[3] (pp. 65–94). According to Professor Paul Davies, without deuterium, "It is doubtful if stable, long-lived stars could exist at all."[4]

At the same time, the electromagnetic force needs to be relatively weak, so that the electrons orbiting atomic nuclei can be rearranged, facilitating chemical reactions and the forming of molecules. In fact, the energy needed to break a strong nuclear bond is about 20,000 times that needed to break an electromagnetic bond (pp. 73–74). Additionally, if the electromagnetic force were just a bit stronger, protons would become unstable leading to a universe full of neutrons and electrons and no elements.[5] Referring to the fine-tuning required of the nuclear strong force and the electromagnetic force, Lewis and Barnes conclude: "Playing these forces off against one-another has a drastic effect on the universe, with an almost imperceptible region of stability" (p. 75). This is illustrated in figure 2.

Let's now turn our attention to the force due to gravity (pp. 107–111). In order for stars (including our sun) to be stable, there must be a balance between the inward pull of gravity and the outward push arising from thermal pressure. If a ball of gas had too little mass, gravity would not squeeze it tightly enough to produce nuclear reactions and it would never shine as a star. If it had too much mass, the force of gravity would produce excessive

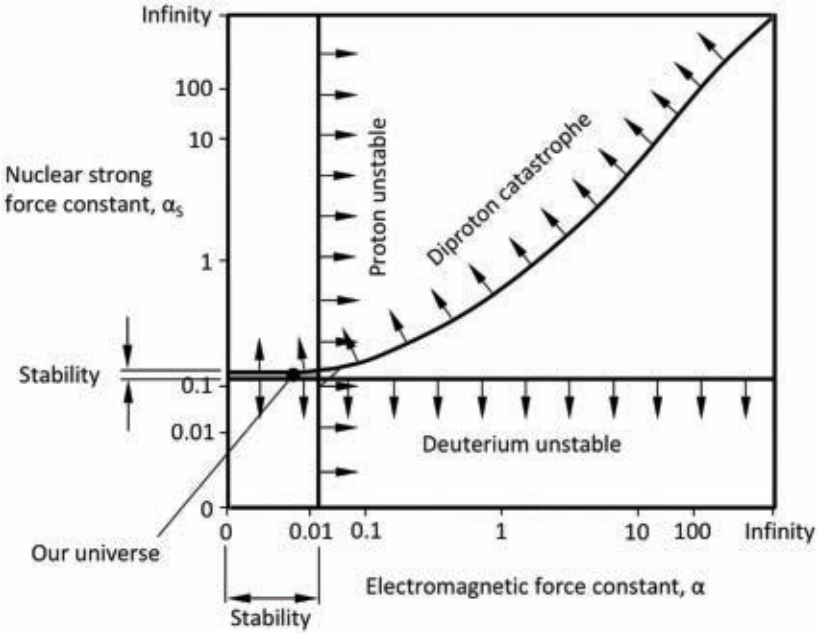


Figure 2. Graph showing the fine-tuning necessary for the electromagnetic force and the strong nuclear force. Below the horizontal line, deuterium would unbind and there could be no sun. Above the curved line, the diproton becomes bound and the sun would burn itself out almost instantly. To the right of the vertical line, protons become unstable. This leaves a tiny region of overall stability (the barely visible thin grey strip), outside of which a universe could not support life. The minuteness of this region becomes apparent when it is realised that the scales are logarithmic and both axes extend to infinity. Our universe is shown as the centre of the black dot. (After Lewis and Barnes, figure 17, p. 75, Tegmark[6] and Barnes[7].)

nuclear reactions, causing the star to burn fuel too quickly, resulting in it blowing off its outer gas layers.

If the force due to gravity were weaker, stars would need to be larger in order to be stable. Such stars would be unsuitable as suns for habitable planets because they would produce low-energy photons such as infrared. These would simply warm the earth like an oven, making processes like photosynthesis unworkable. If the force due to gravity were stronger, stars would need to be smaller. These would, again, be unsuitable for life because they would emit high-energy photons such as gamma rays which would sterilise the earth.

Further to this, it is necessary to consider the electromagnetic force as this also determines the conditions in which nuclear reactions occur and whether a star will be stable. Figure 3 illustrates the extent of the fine-tuning required of the gravity force and the electromagnetic force.

Quantum mechanics and Planck's constant

Most people have been taught that the atom is rather like a solar system: just as planets orbit our sun, so electrons orbit the atomic nucleus. (Although in the case of electrons, the centripetal force maintaining the orbit is electromagnetic rather than gravitational.) It's not that simple however. Orbiting electrons would be expected to lose their energy by emitting radiation—and crash into the nucleus. The answer to this problem lies in the rather esoteric field of quantum mechanics.[8] According to this, the electron is a wave which is constrained to fit within a given orbit. Its wave-like properties, however, are strange: the peaks and troughs indicate where the electron *probably* is and where it is *probably* going. It's a rather uncertain world!

If this quantum weirdness were experienced in respect of larger objects, we would never know quite where things are or where they were going. Balls on a billiard table might behave strangely, "spreading out as they roll until it looked as if not one ball was rolling across the table, but a great number of balls, all partially penetrating into each other" (p. 190). The path of a football sailing through the air might be affected by anything else in the universe (p. 191).

The scale at which quantum mechanics becomes significant is determined by Planck's constant which, in our universe, has the very small value of $\approx 6.6 \times 10^{-34}$ J s. If it were zero, quantum mechanics would not operate and atoms would become unstable. If it were much larger, quantum weirdness would start to affect our everyday lives making the world in which we live unpredictable. Even the ability of DNA to store information would be compromised. Happily, Planck's constant is just where we need it to be (p. 191).

Another consequence of quantum mechanics is that the atoms comprising matter are never still, even in the absence of a heat source. (For this reason, it would be impossible for something to be cooled to absolute zero.) In our universe, where electrons are much lighter than protons, this 'quantum jiggling' is quite gentle, enabling objects to exist in solid form. However, if the electron mass were within a factor of a hundred of the proton mass, everything would melt. Consequently, there would be no solid planets, no stable DNA molecules, and no life (pp. 56–58).

Fine-tuning and the big bang

It is here that Lewis and Barnes' book becomes most useful as, in page after page after page, they explain how parameter after parameter after parameter would have had to be just right for the big bang to have produced a universe capable of sustaining life. In this review it is possible only to mention a few.

Light elements

According to big bang theory, only 'light elements' were formed in the first few minutes of the early universe, these being hydrogen and helium (along with small quantities of deuterium, lithium, and beryllium). In this brief period, the temperature is said to have been just right for nuclei to form from protons and neutrons with the amount of each element being determined by the four fundamental forces (pp. 77–79).

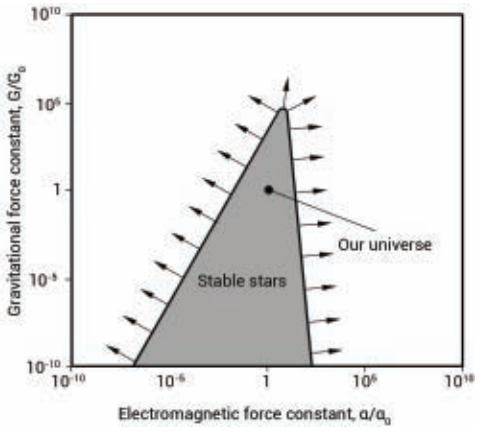


Figure 3. Graph showing the fine-tuning necessary for the electromagnetic force constant, α, and the gravitational force constant, G. α_0 and G_0 are the values of G and α in our universe. Stars become unstable outside of the triangle. Again, the minuteness of the region of stability becomes apparent when it is realised that the scales are logarithmic and may be extended well beyond what is shown. For example, if we used linear scales and extended the vertical axis up to the strength of the nuclear strong force, this would result in the stable region comprising less than one part in 10^{35} of the whole plot. Our universe is shown as the centre of the black dot. (After Lewis and Barnes, figure 21, p. 110.)

If the strong force were greater, nuclear reactions would have been much more efficient and all the hydrogen would have been burnt up, leaving a helium universe. No water (H_20) could then form and there could be no carbon-based molecules involving hydrogen (which accounts for almost all carbon compounds). In fact, increasing the strong force by a factor of about 2 would result in the early universe burning 90% of its hydrogen. Reducing the weak force would also lead to a preponderance of helium due to the nascent universe containing roughly equal numbers of protons and neutrons. (Hydrogen atoms have just one proton and no neutron; helium atoms have equal numbers of protons and neutrons, i.e. two of each.) The gravitational force here is also significant as it constrains how fast the universe expands and therefore how fast it cools. Increasing the gravitational force has the same effect as reducing the weak force—the production of equal numbers of protons and neutrons leading to a helium universe.

The observed abundance of light elements in our universe is said to be prediction of big bang theory and therefore a prediction for it. However, here Lewis and Barnes make a remarkable admission. Having first emphasised how "All four fundamental forces have a say in how much of each element is produced" (p. 76) they state:

> "... changing the strengths of the fundamental forces can have a dramatic effect on the nuclear reactions in the very early Universe ... if there were no nuclear reactions at all ... then we'd be left with pure hydrogen ... . We would, interestingly, be missing a crucial piece of evidence for Big Bang theory" (p. 77).

Hence, it would seem that this alleged evidence for the big bang is itself dependent upon fine-tuning!

The smoothness of the early universe

For stars (and ultimately) planets to have formed, the distribution of matter in the early universe would have needed to be just right. If too even, gravity would never have been sufficiently concentrated so as to draw gases together to form stars. In other words, a degree of 'lumpiness' is needed to provide the 'seeds' of galaxies. If too lumpy, however, stars would be too closely packed together and planets would not have stable orbits. To produce a universe like ours, the density of parts of the universe must have deviated from the average density by approximately 1 part in 100,000, a property referred to as Q. Decreasing Q to 1 part in 1,000,000 would result in no stars, planets, or life. Increasing Q to 1 part in 10,000 would result in nearby stars disrupting planets in their orbits, again making life impossible (pp. 169–170).

The cosmological constant

The cosmological constant describes a repulsive 'antigravity' force arising from 'dark energy', a mysterious property of space, sometimes referred to as 'vacuum energy', that many cosmologists understand to be causing an accelerated expansion of the universe. (The reality of 'dark energy' of course has been contested by creationists who have argued that it is yet another 'fudge factor' required to make the failing big bang theory fit with observations.[9])

According to Lewis and Barnes, the cosmological constant is "just about the best fine-tuning case around" (pp. 163–164). Nobel laureate Steven Weinberg would agree and argues that, unless fine-tuned to 120 decimal places, "the universe either would go through a complete cycle of expansion and contraction before life could arise, or would expand so rapidly that no galaxies or stars could form".[10]

Carbon and oxygen

According to big bang theory, Earth's carbon and oxygen were originally produced inside stars. However, if the strong nuclear force were increased by a little more than 0.4%, stars would produce lots of carbon but not oxygen. Conversely, if it were reduced by the same amount, they would produce lots of oxygen but not carbon (p. 119). Similarly, a small change in the masses of quarks would destroy a star's ability to produce both carbon *and* oxygen (p. 120). Without carbon, carbon-based life could not exist; without oxygen, there can be no water and no life as we know it.

Some have suggested that silicon could replace carbon as the basis for life-permitting molecules. Reality, however, is not so simple. Whereas carbon can form 29,019 compounds with hydrogen, silicon can form only 55. Silicon's equivalent of CO_2 (SiO_2) is a solid crystal (p. 269). Lewis and Barnes do not dismiss the possibility of silicon-based life but argue that this would further constrain the fine-tuning parameters (p. 270).

Objections to fine-tuning

In the penultimate chapter, the authors deal comprehensively with objections to the view that fine-tuning is a reality, and demonstrate that these carry little weight. Interestingly, they comment:

> "The fine-tuning of the Universe for life is unique in our experience for the strength of the opinions expressed. ... Even those who don't think fine-tuning means anything simply must enthusiastically explain to everyone, in great detail, exactly why it doesn't mean anything."

In response to the claim that evolution would adapt life to whatever conditions it finds, they answer that alternative universes are not just uninhabitable because of high levels

of temperature, pressure, saltiness, or acidity; rather:

> "... the extremes of parameter space ... are disintegrating atoms, the cessation of all chemical reactions, the crush of a black hole, and the eternal loneliness of life in a universe where particles collide every trillion years or so" (p. 244).

Some dismiss fine-tuning, claiming that all examples involve changing just one variable and keeping the others fixed. Hence, they say, life-permitting universes might be common if the dials controlling a number of parameters were changed simultaneously. In response, the authors argue that:

> "... spinning multiple dials is usually as destructive as spinning one. ... Sure there are many dials. But there are also many requirements for life. Adding more dials opens up more space [i.e. more possible universes], but most of this space is dead. We see no trace whatsoever of a vast oasis of life" (pp. 256, 261).

This they illustrate for the case of masses of the electron, down quark and up quark. (See figures 4 and 5, both of which show fine-tuning requirements independent of big bang theory.)

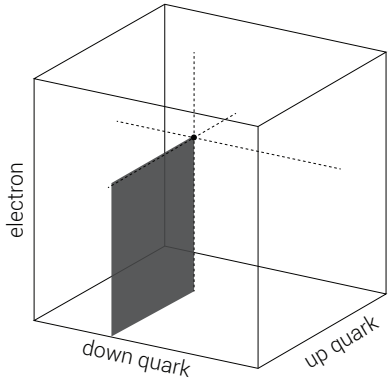


Figure 4. Consideration of the fine-tuning requirements of the fundamental particle masses—step 1. Outside of the thin shaded region, there are only hydrogen universes, neutron universes, universes without chemical reactions, unstable atoms etc (Lewis and Barnes, figure 42, p. 258).

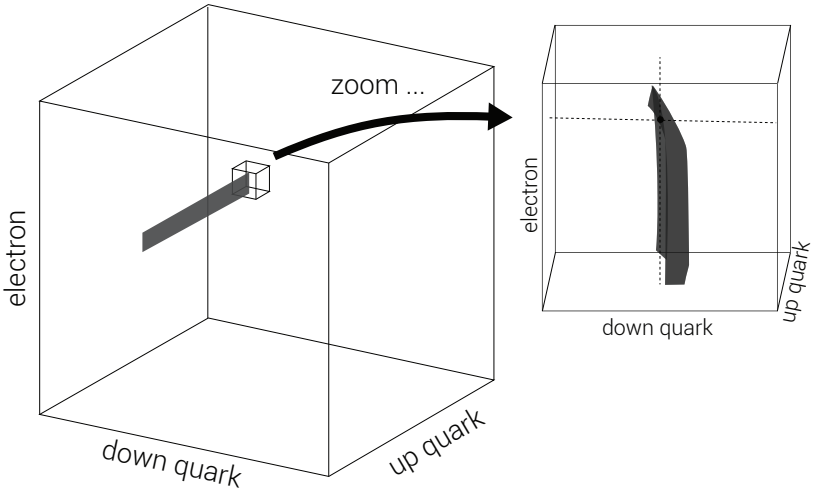


Figure 5. Consideration of the fine-tuning requirements of the fundamental particle masses—step 2. Removing more parameter space associated with stellar instability from figure 4 leaves a tiny life-permitting region (Lewis and Barnes, figure 43, p. 259). If plotted using normal linear scales, we would need a block at least 10 light years high for this to be visible to the human eye.

A designer?

Barnes leans towards the view that the fine-tuning is not accidental but purposeful. To him the universe "contains good things, like free moral agents and all that they can do and learn and appreciate". These, he feels, reflect the intent of a creator (pp. 347–348). Barnes is quite well read on theistic arguments from a largely Thomistic perspective as well as atheistic responses. On his blog, he has been very critical of atheists such as Victor Stenger, Neil deGrasse Tyson, and Richard Carrier.

Lewis is more sceptical and argues that the presence of evil and suffering makes God's existence unlikely: "I would expect a morally perfect being to create a morally perfect universe" (p. 346). He sees a multiverse as a more probable explanation for fine-tuning:

> "Ours is but one of a vast sea of universes, and each with differing laws of physics and properties of matter, set at their birth through some cosmic roll of the dice ... we find ourselves in one of the extremely few universes that can support life—the anthropic principle in action" (p. 353).

Lewis, however, does not appear to have done his homework. The Bible makes clear that the presence of evil and suffering is due to man's sin which led to God cursing an original perfect creation. Realistically, multiverse thinking can have no place in science. Apart from being unobservable (and therefore untestable) it logically leads to the view that no data set should be regarded as evidence for anything. In a multiverse it could always occur by chance! In essence, the "anthropic principle in action" requires the universe to be finely tuned for life as, otherwise, we wouldn't be here to observe it. However, this is really just a truism and fails to explain *why* it is so.

Conclusion

A life-sustaining universe requires a number of fundamental physical constants to be very precisely determined, and creationists rightly view this as evidence of intelligent design.

In addition, the big bang could not produce a life-sustaining universe unless many additional characteristics were exquisitely fine-tuned. This is

so improbable that, to any reasonable mind, such a naturalistic explanation must be seen to be utterly, utterly implausible.

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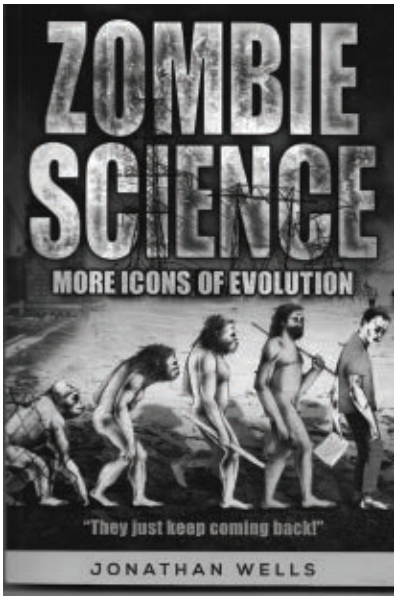
Icons of evolution revisited—all the old and new icons collapse

Zombie Science: More icons of evolution

Jonathan Wells

Discovery Institute Press, Seattle, WA, 2017



John Woodmorappe

In 2002, Dr Jonathan Wells wrote *Icons of Evolution*,[1] in which he identified common themes in college textbooks that are used to illustrate evolution, even though they are dubious or even discredited. In this forceful sequel, he re-examines and expands on this form of non-accidental mis-education.

Wells refutes criticisms of his original work, and shows that, far from being corrected, these icons not only persist, but have also been joined by newer icons. That is why we are dealing with zombie science—wherefrom the title of this book. Wells also shows that evolution, as currently taught, has a stifling effect not only on religion, but also on science itself.

Because there are so many worthwhile topics raised by Wells, it is a bit frustrating not being able to discuss all of them. My review is largely limited to the better-known icons.

Evolutionistic ideology … not innocent mistakes!

One common evolutionistic exculpation for the icons, voiced by leading evolutionists (e.g. Coyne, Pigliucci, Padian, and Gishlick), is that they are merely the kind of trivial errors that inevitably occur in any publication. They most certainly are not. Wells gives the example of a physical science textbook in which a caption and photo had accidently been mismatched (pp. 49–50). It was promptly corrected in the next edition. Not so with the icons, which, as demonstrated repeatedly by Wells, continue to reappear in textbooks year after year after year.

In fact, Wells could have made his case, for the hollowness of the exculpatory 'innocent errors' arguments, even stronger. The high cost of college science textbooks is often explained (away) by the claim that such textbooks must frequently be replaced in order to ensure that they are scrupulously up-to-date and accurate. If that is so, then that is all the more reason that the icons should have disappeared long ago. Instead, editors are in no hurry to correct errors or discredited information in science

textbooks, as long as they promote evolutionary theory.

Perhaps the icons could be excused as myths—that is, as not-quite-accurate stories that are legitimately retained for their educational clarity. Wells will have none of that. He quips:

> "All of the icons of evolution misrepresent the truth. The evidence does not justify the sweeping claims that they are made in their name. They should be empirically dead to any informed, rational observer, but they keep coming anyway. Textbooks still carry them, but textbooks are not the main problem. The main problem is the scientific establishment's determination to promote evolution in spite of the evidence" (pp. 78–79).

It all boils down to this:

> "The icons of evolution are not textbook mistakes. They are used to promote a grand materialistic story even after scientists have shown that the icons misrepresent the evidence. They are tools of zombie science" (p. 169).

A few of the old icons

The Galápagos Island finches go back to Charles Darwin and his *Origin of Species*. However, they did not show what is claimed for them then and they still do not show it now. Wells comments:

> "The Galápagos finches have provided evidence for differential survival correlated with environmental changes—that is, for natural selection. But the finches do not provide evidence for the origin of new species, organs or body plans—that is, for evolution" (p. 70).

Now consider the peppered moths. They persist as icons even though, a few decades ago, studies had demonstrated that peppered moths do not normally alight on tree trunks as illustrated in biology textbooks. Consequently, differences or similarities between the colouration of the tree trunk and the colouration of the moths are irrelevant to the moths' survival. Moreover, newer studies have failed to convincingly demonstrate that the observed numerical asymmetry of light and dark moths has anything to do with differential vulnerability to predators in the first place.

The giraffe, with its long neck, is an iconic example of evolution in action. According to textbook orthodoxy, wrong-guy Lamarck had suggested that constant neck-stretching by the giraffe had eventually caused the neck to lengthen in successive generations, while our hero, right-guy Darwin, had correctly suggested that natural selection had favoured the survival of the long-necked giraffe, at the expense of short-necked giraffes, owing to the ability of the long-necked variant to reach high forage. Wells discusses the inferred mutations behind the alleged evolution of the long neck. However, he could have pointed out that the textbook account is a gross oversimplification. There are in fact *several* different currently held evolutionary hypotheses, all of them conjectural, for the long neck. For example, instead of reaching high vegetation, the long neck may actually be the outcome of sexual selection. Alternatively, and in addition to the giraffe's long legs, the long neck may be the response to selective pressures for thermoregulation (that is, a heat-dissipating increase in the ratio of body surface area to body volume).

Now consider another hoary icon—the 'human tail'. Wells shows that it is nothing more than a birth defect. However, he could have made his case stronger by considering birth defects that no evolutionist would claim to be 'atavisms'. Thus, for example, the sixth finger is a birth defect, nothing more. However, had evolutionists believed that humans evolved from six-fingered ancestors, then surely a sixth finger today would be proclaimed an evolutionary 'atavism', and elevated into an icon.

No discussion of old evolutionary icons would be complete without the appendix—the vestigial organ par excellence. Wells summarizes numerous evidences that the appendix is functional—as a lymphoid organ and as a reservoir of intestinal bacteria. Faced with this evidence, some evolutionists have now conveniently redefined the term 'vestigial organ' to mean one with a reduced function instead of a non-existent function. This effectively eliminates the original vestigial-organ argument by folding it into the one on homologies. That is, the structure in organism (A) does something different from the corresponding structure in organism (B). Big deal. And, as in all evolutionary arguments based on homology, it does not tell us if this difference arose from common evolutionary ancestry or if it arose from common design by a Designer. In addition to this, the 'reduced function' argument assumes that something qualifies as a 'full' function. It is frankly laughable. For instance, if evolutionists believed that bicycles had all evolved from a common ancestor, would they be saying that the switchable multi-gear bicycle is a manifestation of full function, while the single-gear bicycle exhibits reduced function, and is therefore vestigial?

Other evolutionists (e.g. Jerry Coyne) have 'moved the goalpost' further by re-defining a vestigial organ as one with a changed function instead of non-existent function. What does this imply? Wells points out that, owing to the fact that it appeared earlier, the tetrapod limb serves as a reference for the original function. That would mean that its homologue in the human—the arm—would have to be one that has 'reduced' function, and is therefore vestigial according to the redefinition. Such is the *reductio ad absurdum* of the evolutionistic back-pedalling on vestigial organs.

Some new icons: biological molecules

So-called junk DNA is a well-known icon. Wells recounts the growing body of evidence that it is functional. Moreover, such DNA can have a function even if the sequence is not conserved from organism to organism. It shows only that the function is unrelated to sequence specificity.

Sequences of DNA are called genes, and the latter have assumed unwarranted iconic status. This has even included the identification of claimed genes that cause alcoholism, violence, homosexuality, and even political views. The fatal flaw of this approach is described by Wells. Behavioural geneticists examine a group of people, exhibiting a certain behaviour, in terms of genes that occur more commonly among members than among outsiders. However, if you look at enough genes, some of them are bound to occur more commonly in that group, solely by chance.

Pseudogenes especially had assumed iconic status in evolution as disabled genes—that is, as self-evident relics of dysteleology and evolution. We now know, however, that at least some of them are functional.

On another subject, evolutionists have struggled to deal with the contradictions in phylogenies created from molecular data. They finally have had to resort to special pleading by supposing that not all sequences carry what they call 'strong phylogenetic signals'. This, too, is an exercise in circular reasoning.

Some new icons: genes that govern development

The *Hox* genes have become one of the new icons. They are similar across widely divergent organisms, but manifest themselves very differently. Some evolutionists have claimed that experiments on regulatory genes show that wholesale reorganizations of macro-organisms can occur in only one generation (similar to the old 'hopeful monster' idea, though this phrase is not used by Wells). They do no such thing. The experiments have failed to show any kind of biological novelty. Wells quips:

> "Fruit flies with useless extra wings or missing legs have taught us something about developmental genetics, but nothing about how evolution might build new form and function. All of the evidence points to one conclusion: No matter what we do to the DNA of a fruit fly embryo, there are only three possible outcomes: a normal fruit fly; a defective fruit fly, or a dead fruit fly. Not even a horse fly, much less a horse" (p. 94). (Figure 1.)

Jonathan Wells has a way with words. I love it!

Now consider the *Pax-6* gene, which is responsible for the development of the eye in various dissimilar creatures. The mouse *Pax-6* gene can be transplanted into a fruit fly, and the fruit fly will develop ectopic (out of place) eyes. But these will be fruit fly eyes, not mouse eyes. This fails as evidence for evolution, as explained by Wells:

> "If *Pax-6* were in control, the fruit fly gene would presumably generate a fruit fly eye, the mouse gene a mouse eye, the squid gene a squid eye, and so on. In fact, *Pax-6* is not a master control gene at all; it is just a switch. The ignition switch from a car can be installed into a boat or an airplane and serve the same function. But the car's ignition switch doesn't turn a boat or an airplane into a car. Calling an ignition switch a 'master control device' doesn't tell us anything about the nature or origin of the vehicle in which it is found" (p. 135).

Well said.

Figure 1. A fruit fly with legs where there should be antennae (antennapedia). As pointed out by Wells in such acerbic fashion, this is nothing but a malformed fruit fly, and most certainly does not qualify as evidence for evolution.

Some new icons: human physiology

One of the most commonly repeated new icons is the 'backwards' retina in the vertebrate. This icon is one of many 'bad design' arguments that are supposed to show that no Intelligent Designer made it. Instead, it is supposed to show that evolution lacks foresight, that it can only modify what had existed before in jury-rigged fashion, and that it is a minimum-solution system. However, Wells shows that the octopus eye, despite its 'proper' deployment of retina and blood vessels, is actually inferior in function (visual acuity) to that of the vertebrate eye. In addition, on close examination, it turns out that the 'properly' wired retina is far from optimal even for the bare function of a vertebrate eye. That is, were the high resolution demanded of the vertebrate eye to be expressed in terms of a design utilizing a 'properly' wired retina, the vertebrate eye would have to be impossibly large. Therefore, far from being 'bad design' or something 'jury-rigged', the 'backwards' vertebrate retina is actually an intelligent, space-saving, engineered structure that is necessary for the high resolution of the vertebrate eye at a reasonable size. Despite these facts, the evolutionist icon of the 'backwards' retina continues to be uncritically repeated, no doubt for its intuitively appealing, pro-evolutionary emotional impact.

Cancer itself has now become enlisted as an icon of evolution. At best, all it shows is that, unsurprisingly, natural selection favours those rogue cells that can defeat the body's immune system, thwart oncologists' efforts to eradicate them, and to multiply in a most berserk fashion. But none of this has anything to do with evolution. Wells notes that, "Darwinian evolution needs examples of biological processes that build new forms and functions. Cancer destroys these things" (p. 168).

Some new icons: paleontology and cladograms

The old-fashioned evolutionary trees have largely been replaced by cladograms, and these have become an icon of sorts. Owing to their visual appeal and misleading implications, they constitute a subtle evolutionary propaganda acting on the minds of unsuspecting students. Cladograms do not show ancestor-descendant relationships, and are untrue insofar as they presume, rather than demonstrate, that shared traits are the result of evolution. As a matter of fact, Wells cites a classroom activity that involves the construction of cladograms from common objects[2], such as nails, screws, and paperclips. Yet, ironically, no one suggests that screws and nails are related to each other by evolution. They are independent, special creations, and any polarities or nested hierarchy based on them are in no sense evidence for their evolution.

I have shown this earlier in more detail (figure 2) in my spoof cladogram. All of the machines are independent, special creations, and no one would even imagine that these machines and their cladistic deployment were caused by evolution. Yet that is *exactly* what unsuspecting students are led to believe whenever they see a cladogram of organisms in their textbooks.

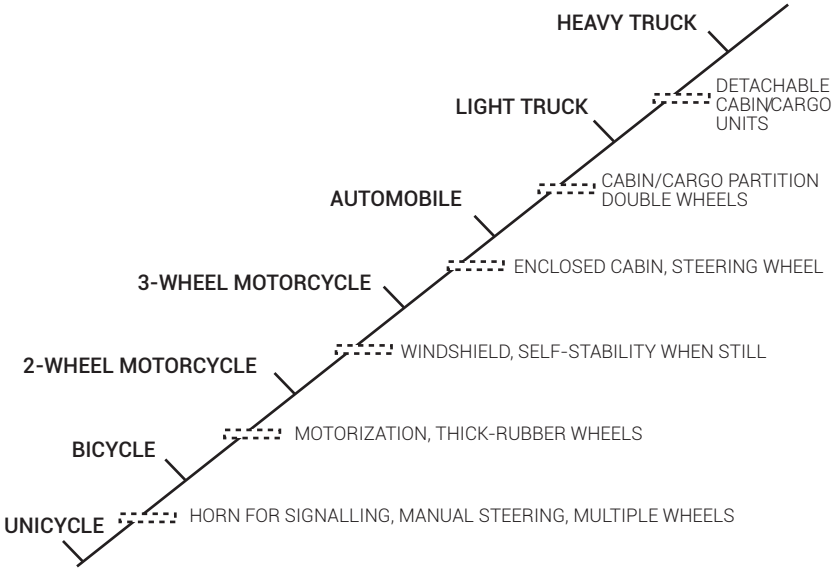


Figure 2. A spoof cladogram: from unicycle to 18-wheeler truck. Shown as figure 3 in my study of whale evolution.[3]

Whale evolution—a shattered new icon

The author criticizes the standard narrative on whale evolution. He discusses the fragmentary nature of the fossils, which makes their inter-comparison difficult, and the imaginative artistic licence of their inferred lifestyles. The actual evidence indicates that the 'intermediates' can best be understood as semiaquatic creatures similar to today's otters and crocodiles—animals that have nothing to do with whales.

Jonathan Wells thus confirms, updates, and expands my 2002 study on whale evolution[3]. He especially focuses on the many unique specializations of the whale for its fully aquatic lifestyle, many of which create

a gulf between whales and amphibious vertebrates, and many of which are not preserved as fossils. For instance, the cetacean mother has a unique way of nursing her calves that occurs underwater yet allows them to come to the surface to breathe.

Interestingly, the involucrum, a peculiar bone in the middle ear that is used to define the cetacean clade (the same way that the pneumatic tire defines my spoof clade; figure 2) now has been found in other fossil creatures that evolutionists don't believe are closely related to whales. This means that, following evolutionistic thinking, the involucrum is convergent in at least two distinct groups, or it is a relatively common feature that is shared by many non-cetaceans and cetaceans. In any case, the involucrum can no longer define the cetacean clade. Either some other trait must be found to do so, or the clade must be broken up.

Finally, Wells points out that some of the 'fossil whales' are contemporaneous. He could have made his case a lot stronger by factoring the statistics of stratigraphic ranges. That is, a single, or few, specimens suffer from a large built-in uncertainty as to the limits of their actual stratigraphic interval (including first appearance). Additional uncertainties about the actual (as opposed to observed) first appearance of a taxon are imposed by such things as the vagaries of the area of outcrop available to be surveyed, the potentially uneven collecting intensity conducted by paleontologists, the random or non-random spacing of fossiliferous horizons, and other factors.[4] Consequently, to speak of stratomorphic intermediates (that is, a less-derived organism necessarily preceding a more-derived organism in the stratigraphic record) is premature at best. Of course, this consideration applies not only to whales, but also to the unmentioned iconic mammal-like reptiles, and other organisms.

Evolutionistic triumphalism challenged on multiple fronts

The author does not mention the many advances made by scientific creationists, but he does touch on those of ID proponents. The reader learns, for example, of the Biological Institute founded by molecular biologist Douglas Axe. This scholar focuses on the practical teleology of enzymes.

The Sociedade Brasileira do Design Inteligente (Brazilian Society for Intelligent Design) is notable for its spectacular growth. In 2014, there had been a conference that had attracted hundreds of people. Back in 1998, all those interested in the subject could, according to Wells, have fitted in a Volkswagen van.

One hindrance to the greater success of ID research is money to support research. Evolutionists have a monopoly on taxpayer funding (to the tune of billions of dollars annually in the USA alone). Hence, ID must rely on private funding.

Pointedly, the challenges to evolutionistic dogma are not coming solely from creationists and IDers. A growing number of evolutionists, while firmly remaining materialistic evolutionists, themselves are recognizing the inadequacy of Darwinian orthodoxy. For instance, the so-called Altenberg 16 published a collection of essays in 2010 in which they challenged the standard notion that organisms could evolve solely through the gradual accumulation of small variations incrementally preserved by natural selection.[5] Two other evolutionists, Jerry Fodor and Massimo Piattelli-Palmarini, advanced the heretical notion that the role of natural selection in evolution has been greatly exaggerated, and that an organism's postulated 'internal factors' are more important drivers of evolution. Evolutionist James Shapiro was even more radical. He dared suggest that cells can reorganize their genomes in purposeful ways. Taking this further, evolutionist Denis Noble came out and said that the neo-Darwinian conception of evolution is wrong. In other words, the central tenets of neo-Darwinism are no longer valid.

Call the rationalist thought police before it's too late!

Jonathan Wells brings out the hysteria of the evolutionists that becomes manifest in the face of scholarly challenges to their materialistic worldview. I mention the inanities of some of these evolutionists and poke fun at them.

We have evolutionary biologist Massimo Pigliucci, who says that creationism is evolution denial, as is ID, and that—horror of horrors—it is bent on literally destroying science as we know it. Wow! I know some ID members, but never realized that IDers could be *that* naughty.

Biologist and journal editor Gerald Weissman shrieked that our heritage of reason, stemming from the Enlightenment, is being eclipsed by what he calls the Endarkenment. Niall Shanks is even better: He frightens us that creationists want to turn the clock back to medieval times (he apparently doesn't realize that medieval times gave us the university and mechanical clocks, among many other things). Now, creationists have achieved many things, but why have we never realized that creationists have mastered the ability to make time flow backwards? That's a new one.

Not to be outdone, physicist Marshall Berman wrote that ID poses a threat not only to science but perhaps to secular democracy itself. So what exactly are creationists? Fascists? Communists? (Oops, no—these two groups were evolutionists.) Malevolent aliens from another planet? Kenneth Miller warned that, were ID to succeed, the modern age would be brought to an end. What unearthly powers those IDers must have!

The pretence of the compatibility of God and evolution (the universal acid)

Evolution is not 'just a theory'. It is not for nothing that it is called the 'universal acid', as it profoundly transforms whatever it touches.

Reality cannot be compartmentalized. Those who accept evolutionist Stephen Jay Gould's rather disingenuous dictum, about evolution and religion belonging to 'non-overlapping magisteria', are out of touch with reality. To begin with, science is supposed to deal with factual matters, while religion is relegated to subjective feelings and imagination. This, right there and then, is prejudicial to religion. Wells quips:

> "In effect, this is just a restatement of materialistic philosophy. It's a bully tactic to convince religious believers that they are not entitled to say anything about objective reality" (p. 172).
>
> No kidding.

The more and more that is claimed for the explanatory power of evolution, the greater the overlap of the two magisteria. Additionally, the magisterium assigned to religion keeps shrinking and shrinking.

Now consider some painful realities. Wells cites studies that show that a significant number of those raised as Christians have turned away, and now are 'nones'. Of these, about half indicated that they had done so because they had stopped believing what they had once believed. Of the latter, a large fraction indicated that this had happened because of the conflict of their previous beliefs with the 'facts of science'. Surely they are not referring to Newton's Laws of Motion (discovered by a creationist!). It is vividly obvious that the dominant and constantly repeated "You can believe in God and evolution at the same time" mantra did not impress them. Yet, as elaborated by Wells, we see all kinds of Christian clergymen (and not only liberals, but also notably compromising evangelicals) triumphantly going around condemning creationism and Intelligent Design, and proclaiming that God and evolution are effectively bosom buddies. Get real!

Conclusions

Clearly, the icons of evolution are no innocent little errors. They are intentional—done to promote evolutionism and its materialism at all costs. They are a form of intellectual dishonesty—but some evolutionists are OK with deception if it furthers belief in evolution.[6] The fact that unsuspecting children and uninformed young adults are the main target of this evolutionary propaganda makes it all the more inexcusable.

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Radiocarbon in coal: is uranium the answer?

Jim Mason

Radiocarbon (^{14}C) found in coal by the RATE project is problematic for those who believe in the hundreds of millions of years ascribed by uniformitarian geologists to the Phanerozoic geological column. Given the sensitivity of the measuring instruments and the assumptions used in translating these measurements into a radiocarbon 'age', anything older than about 90,000 years would have an undetectable level of ^{14}C. Various hypotheses have been put forward to try to explain such ^{14}C within the 'long-age' paradigm. One is that the ^{14}C results from the presence of uranium in the coal or an adjacent ore body. Detailed analysis shows, however, that this hypothesis completely fails. Moreover, readily available data shows that the detected amount of ^{14}C is consistent with the biblical timescale when we allow for differences between ^{14}C-to-^{12}C ratios in the atmosphere today and the pre-Flood era.

Baumgardner, in one study[1] of the RATE[2] project, sent coal samples he obtained from the US Department of Energy to "one of the foremost Accelerator Mass Spectrometer (AMS) laboratories in the world"[3] for ^{14}C dating. These tests showed substantial amounts of ^{14}C present. These coal samples were from several disparate locations in the US, and from three separate layers in the geological column conventionally 'dated' to 37–56 Ma, 71–145 Ma, and 304–318 Ma, respectively. The sensitivity of the AMS machines, the half-life of ^{14}C, and the assumption about the ^{14}C-to-^{12}C ratio in the sample at the time it stopped living together imply that after about 90,000 years there will be insufficient ^{14}C in any sample to be detected.

The level of ^{14}C detected was well above the minimum design sensitivity of the machines (c. 0.002 pMC[4]), being in the range 0.10 ± 0.03 to 0.46 ± 0.03 pMC. These values resulted from four separate runs on each sample, the uncertainty-weighted average of which was then 'corrected' by subtracting a 'standard background' of 0.077 ± 0.005 (table 1). This 'standard background' was measured from the ^{14}C to ^{12}C ratio in a natural gas sample assumed to be so old it would contain no detectable ^{14}C, so any measured amounts 'must be' due to 'background'. Should this assumption be incorrect (i.e. the natural gas is not as old as assumed), then the measured 'background' would be 'real' ^{14}C, and the results reported for the coal should be increased by 0.077 in each case.[5]

The mean results for the coal were 0.247 pMC, the median, 0.235 pMC, and the mode of a binned histogram (figure 1), about 0.225 pMC. The median value, 0.235 pMC, will be used in the calculations below. This level of ^{14}C is problematic for the standard geological timescale. This is why uniformitarians try to explain the ^{14}C as resulting from the presence of uranium, either in the coal or adjacent deposits.

Rotta[6] discusses various evolutionary explanations for this anomalous ^{14}C content. He discusses cluster decay of uranium and its 'normal' decay progeny, ternary fission of uranium/thorium, neutron absorption by ^{14}N, and contamination by atmospheric ^{14}C.

In cluster decay and ternary fission, one of the products can be ^{14}C. However, Rotta shows that the probabilities of these decay modes compared to those of normal alpha particle decay and binary fission are so small that they produce too little ^{14}C to explain the measured values. Regarding contamination by atmospheric ^{14}C, Rotta notes that this should result in wide ranges of ^{14}C-to-^{12}C ratios in different coal beds due to the different exposures of these coal beds to the atmosphere over their alleged history. However, the observed uniformity in the observed levels of ^{14}C rules this out.

The absorption of thermal neutrons by ^{14}N is the same mechanism examined here. Rotta approached it using a 'thin layer' approximation, whereas we approach it from the perspective of a uniformly distributed neutron source in a spherical volume of indeterminate extent, similar to what is encountered in a nuclear power reactor. For completeness, we also examine the potential for ^{14}C being produced by the 'normal' decay products of uranium, i.e. alpha and beta particles.

Forming ^{14}C from uranium

Normally, ^{14}C is produced in the atmosphere when cosmic rays collide with nuclei in the upper atmosphere causing spallation, a process which also produces neutrons. These neutrons are absorbed by the ^{14}N nuclei in the atmosphere which then emit a proton and transform into ^{14}C. Clearly, this process cannot proceed deep underground, hence the appeal to uranium.

Uranium most commonly transforms through 'normal' radioactive decay, in which uranium transforms into lead through several intermediary elements, emitting several alpha particles, beta particles and gamma rays in the process.

Table 1. Measured ^{14}C levels in 10 coal samples (from Baumgardner[1])

Sample	Coal seam name	State	Country	Geological interval	14C/12C (pMC)	Experimental uncertainty (±) pMC
DECS-1	Bottom	Texas	Freestone	Eocene	0.30	0.03
DECS-11	Beulah	North Dakota	Mercer	Eocene	0.20	0.02
DECS-15	Lower Sunnyside	Utah	Carbon	Cretaceous	0.35	0.03
DECS-16	Blind Canyon	Utah	Emery	Cretaceous	0.10	0.03
DECS-18	Kentucky #9	Kentucky	Union	Pennsylvanian	0.46	0.03
DECS-21	Lykens Valley #2	Pennsylvania	Columbia	Pennsylvanian	0.13	0.02
DECS-23	Pittsburgh	Pennsylvania	Washington	Pennsylvanian	0.19	0.02
DECS-24	Illinois #6	Illinois	Macoupin	Pennsylvanian	0.29	0.03
DECS-25	Pust	Montana	Richland	Eocene	0.27	0.02
DECS-28	Green	Arizona	Navajo	Cretaceous	0.18	0.02

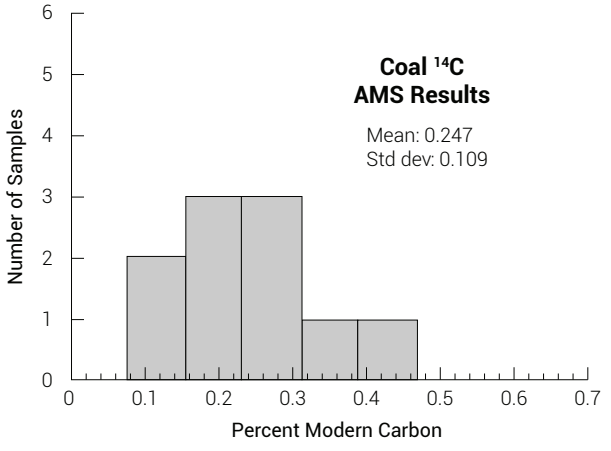

Figure 1. Histogram of number of samples as a function of observed ^{14}C level measured as pMC (figure 4 from ref. 1)

However, neither alpha particles, beta particles, nor gamma rays can produce ^{14}C in coal.

Producing ^{14}C using alpha particles requires starting with ^{10}Be. In the atmosphere, ^{10}Be is produced at a very slow rate by cosmic ray spallation of oxygen. It is unstable and decays by beta decay with a half-life of about 1.39 Ma.[7] While Be is listed[8] as comprising 1–2 ppm of coal, this would necessarily have been buried with the initial vegetation that formed the coal. Therefore, given the alleged 37 Ma since the 'youngest' coal sample, any ^{10}Be would have decayed to only about 10^{-8} of its original value. Consequently, it can be confidently concluded that any Be in the coal is the stable isotope ^{9}Be, with the result that the alpha particles emitted by the radioactive decay of uranium cannot be the source of the ^{14}C in the coal.

Producing ^{14}C with an electron (beta particle) would involve a proton in a nucleus absorbing an electron and transforming into a neutron:

$$p + e \rightarrow n + \nu_e,$$

where p is a proton, e is an electron, n is a neutron, and ν_e is an electron neutrino. This is an electron capture reaction. In such a reaction, the nucleus absorbs either a K-shell or L-shell electron from the electrons surrounding the nucleus as part of the constituent atom. The nucleus does not capture a free electron, such as would be produced in beta decay. Moreover, to form ^{14}C, such a reaction would need to start with ^{14}N, which is a stable isotope that does not undergo electron capture—or indeed 'decay' of any sort.

Gamma rays, since they contain neither a proton nor a neutron, cannot change the isotope and so could only serve to move an already existing ^{14}C nucleus to a higher energy level. Consequently, gamma rays cannot produce ^{14}C in coal.

The only mechanisms that would be able to produce ^{14}C are all thermal neutron capture reactions involving ^{14}N, ^{13}C, and ^{17}O as the starting point.[9] Given the relative abundances of these isotopes and their cross-sections for the associated reactions, only the one starting with ^{14}N might contribute significantly. This is the same reaction that produces ^{14}C in the atmosphere.

The only source of neutrons would be from spontaneous fission of uranium, either ^{238}U or ^{235}U. Since ^{238}U comprises 99.274% uranium[7] while ^{235}U comprises only 0.720%[7] and ^{238}U fissions spontaneously at a rate at least 42 times that of ^{235}U,[10] ^{238}U produces far more neutrons per second per g of material than does ^{235}U. Consequently, we can limit our consideration to just ^{238}U.

The neutrons resulting from ^{238}U fission have an energy of about 2 MeV (known as 'slow' neutrons), whereas the most effective neutrons for capture by ^{14}N to produce ^{14}C are 'thermal' neutrons with an energy of 0.025 MeV. Thus, the neutrons produced by the fission need to have their energy reduced, which would be accomplished by collisions with the surrounding carbon (and other) nuclei. In fact, carbon

and/or hydrogen (either as water or paraffin) are often used as 'moderators' in nuclear power reactors to do exactly this.

So, the overall process would be:

- a ^{238}U nucleus undergoes spontaneous fission, producing two (actually 2.07) 'slow' neutrons
- these neutrons collide with surrounding nuclei and have their energy reduced to thermal energies
- these thermal neutrons are absorbed by a proton in ^{14}N nuclei to become, in effect, ^{15}N, which then emits a proton to become ^{14}C, i.e. $n + {}^{14}_{7}N_{7} \rightarrow ({}^{15}_{7}N_{8}) \rightarrow {}^{14}_{6}C_{8} + p$
- the ^{14}C decays to ^{14}N by emitting a beta particle.

Quantitative considerations

The simplest way to think about this process is as a two-step 'decay' chain. That is, radioactive element A 'decays' to produce radioactive element B, which, in turn, 'decays' to stable element C:

$A \rightarrow B \rightarrow C$

In this case, A is ^{238}U, B is ^{14}C, and C is ^{14}N. Normally, B is directly produced from A by simply removing the 'decay radiation' (alpha particle, beta particle, or gamma ray) from the nucleus of A. However, in this case, B (^{14}C) is indirectly produced from A (^{238}U) through fission, a process which produces neutrons, and the subsequent absorption of these neutrons by an intermediate (^{14}N) then transforms ('decays') to B (^{14}C). The steps from ^{238}U to ^{14}C via ^{14}N, however, can be considered as a single-step pseudo-transformation of ^{238}U to ^{14}C, where the transformation 'rate' is suitably adjusted to reflect the delayed outcome of the 'decay' of a single atom of ^{238}U to form a single atom of ^{14}C.

Since what is measured is the amount of ^{14}C in the coal (or, more precisely, the ratio of ^{14}C to ^{12}C), what must be determined is the number of ^{14}C atoms present at any particular time, t. This can be ascertained from the differential equation for the cascade 'decay' chain, namely

$$\frac{dN_B}{dt} = \lambda_A N_A - \lambda_B N_B \quad (1)$$

where N_B= the number of atoms of element B present at time t (^{14}C in this case), N_A= the number of atoms of element A present at time t (^{238}U in this case), λ_A= the 'decay' rate of element A, and λ_B= the 'decay' rate of element B. $\frac{dN_B}{dt}$ is the rate of change of the number of atoms of element B at time t, $\lambda_A N_A$ is the rate at which atoms of element B are appearing as a result of the transformation of atoms of element A to element B at time t, and $\lambda_B N_B$ is the rate at which the atoms of element B are disappearing as the result of the transformation of element B to element C at time t.

In general, one would solve this equation to find an expression for N_B. However, because of the relationship of the 'decay' rates, a simplification is possible. 'Decay' rate is related to the half-life, which is the time required for one half the amount of a radioactive substance present at any given time, t, to transform into its 'decay' product. This relationship is given by

$$\lambda = \frac{\ln(2)}{T_{1/2}} \quad (2)$$

The half-life of ^{14}C is 5,700 ± 30 years.[7,11] The half-life for the spontaneous fission of ^{238}U is around 8.27×10^{15} years.[12]

In situations like this, where the half-life of element A (^{238}U) is much longer than that of element B (^{14}C), the cascading process reaches an equilibrium, known as the secular equilibrium, where enough of element B has accumulated that the rate of atoms transforming to element C equals the rate at which atoms of element A are transforming into element B. This usually takes only a few half-lives of element B. At this point, the rate of change of the number of atoms of element B becomes zero:

$$\frac{dN_B}{dt} = \lambda_A N_A - \lambda_B N_B = 0 \quad (3)$$

From this equation, N_B can be determined:

$$N_B = \frac{\lambda_A N_A}{\lambda_B} \quad (4)$$

Another consideration is rate of change of N_A, especially the amount of change during the half-life of B. This is given by

$$\frac{N_A}{N_A(0)} = e^{-\lambda_A t} = e^{\left(-0.693\frac{T_{1/2C14}}{T_{1/2U238}}\right)} = 0.9999999999995 \quad (5)$$

Thus, it is reasonable to treat the number of ^{238}U atoms as constant over a few half-lives of ^{14}C. Even over the alleged age of the oldest sample of coal, the number of ^{238}U atoms would reduce by a factor of only 0.99999997.[13]

However, equation (5) assumes that every atom of A directly results in an atom of B, which is not the case for the ^{238}U-to-^{14}C transformation. Instead, the fission process produces (on average) 2.07 neutrons[10] that are slowed to thermal energies and then absorbed by the ^{14}N nuclei.

However, a thermal neutron will not necessarily be absorbed by the next nitrogen nucleus it encounters. It could simply be scattered or 'bounce off' in another direction. This is also true for the nuclei of any other elements in the coal, such as carbon and uranium. The net effect is that the thermal neutron 'bounces around' in the coal for some time before being absorbed. This essentially decreases the effective 'decay' rate (or increases the effective half-life) of the ^{238}U-to-^{14}C transformation.

The probability of either scattering or absorption happening depends on the cross-sections of the ^{14}N nucleus for these respective processes. These cross-sections are the

effective areas that the nucleus presents for scattering or absorptive collisions. The number of absorptions per second per cm³ is thus given by

$$\Phi\sigma_a N_N \tag{6}$$

where Φ is the neutron flux in neutrons per cm² per second, σ_a is the neutron absorption cross-section of ^{14}N in cm², and N_N is the number of ^{14}N atoms per cm³ exposed to the neutron flux.

Effect of uranium content of the coal

Now consider the case of the ^{14}C being generated from ^{238}U in the coal itself. In addition to carbon and nitrogen, coal contains a significant amount of hydrogen as well as trace amounts of other elements. Hydrogen nuclei (protons) have a considerable interaction with neutrons, especially non-absorptive scattering, because of the nearly identical masses of the proton and neutron. Consequently, it is necessary to include the hydrogen content of the coal in these considerations.

The relative amounts of the three major elements vary depending on the type of coal but are typically in the following ranges: C: 75–90%, H: 4.5–5.5%, N: ~1.5%.[14] For the purposes of this analysis the following percentages will be used: C: 93%, H: 5.5%, N: 1.5%, (sum = 100%) except when it comes to calculating a ratio of nitrogen to carbon, in which case 1.5:75 = 0.02 will be used as this provides the maximum concentration of nitrogen to convert to ^{14}C.

Assume that the uranium, hydrogen, and nitrogen are uniformly distributed throughout the coal and let N_{U238} be the number of ^{238}U atoms, N_{C14} be the number of ^{14}C atoms, N_H be the number of hydrogen atoms, and N_{N14} be the number of ^{14}N atoms per cm³, respectively. The uranium atoms will be undergoing spontaneous fission and generating neutrons at a rate of λ_f fissions per second and 2.07 neutrons per fission.

Consider now a sphere of radius R. The neutron flux within this sphere is given by[15]

$$\Phi(r) = \frac{S}{\Sigma_t}\left[1 - \frac{R+d}{r}\frac{\sinh\left(\frac{r}{L}\right)}{\sinh\left(\frac{R+d}{L}\right)}\right] \tag{7}$$

where S is the number of neutrons per sec/cm³ being generated by the uniformly distributed uranium atoms, Σ_t is the macroscopic scattering cross-section in cm^{-1}, R is the radius of the sphere, in cm, d is the extrapolated length in cm, and L is the diffusion length in cm.

The macroscopic scattering cross-section $\sigma_t = \sum_{i=1}^{n}\sigma_i N_i$ where $\sum_{i=1}^{n}$ represents the sum over the various elements in the material, σ_i is the microscopic scattering cross-section for element i, and N_i is the number of atoms per cm³ of element i.[16,17]

The extrapolated length, d, is the distance beyond the sphere at which the neutron flux is assumed to go to zero by extrapolating its rate of change with distance at R (a boundary condition used to solve the diffusion equation); d ~0.71 λ_{tr} where λ_t is the mean free transport length. The mean free transport length is the average distance the neutrons will have moved in their initial direction after an infinite number of collisions with other nuclei.[18]

The diffusion length, $L = \sqrt{\frac{D}{\Sigma_a}}$, where $D = \frac{1}{3(\Sigma_a + \Sigma_{tr})}$ is the diffusion coefficient, and Σ_a and Σ_z are the macroscopic cross-sections for absorption and transport, respectively.[19]

Values for these parameters for the elements under consideration herein are given in table 2.

In calculating the macroscopic cross-sections and related parameters, we must determine the number of carbon, hydrogen, and nitrogen atoms per cm³ of coal. To do this, a hypothetical coal 'molecule' was defined as consisting of 0.93 atoms of carbon, 0.055 atoms of hydrogen, and 0.025 atoms of nitrogen, which would then have a molecular weight of 11.425 g/mole. Using a density of 1.35 g/cm³ for coal,[20] we can then calculate the number of moles of this coal molecule per cm³ (0.1182), and from this the number of atoms of carbon, hydrogen, and nitrogen per cm³, respectively.

Note that for the aggregate coal, the transport mean free path, the extrapolated path, and the diffusion length are all in the order of a few cm. This means that the neutron flux at any point is determined only by the coal near a few tens of cm (at most) of the point under consideration, and the actual size of the overall coal bed is not significant.

Multiplying the denominator of the second term inside the bracket in (7) by L/L gives

$$\Phi(r) = \frac{S}{\Sigma_t}\left[1 - \frac{R+d}{\left(\frac{L}{L}\right)r}\frac{\sinh\left(\frac{r}{L}\right)}{\sinh\left(\frac{R+d}{L}\right)}\right] \tag{8}$$

which can be rearranged to give

$$\Phi(r) = \frac{S}{\Sigma_t}\left[1 - \frac{R+D}{L\left(\frac{r}{L}\right)}\frac{\sinh\left(\frac{r}{L}\right)}{\sinh\left(\frac{R+d}{L}\right)}\right] \tag{9}$$

and further rearranged to give

$$\Phi(r) = \frac{S}{\Sigma_t}\left[1 - \frac{\left(\frac{R+d}{L}\right)}{\sinh\left(\frac{R+d}{L}\right)}\frac{\sinh\left(\frac{r}{L}\right)}{\left(\frac{r}{L}\right)}\right] \tag{10}$$

Table 2. Values for various parameters relating to determining the neutron flux in coal resulting from spontaneous fission of uranium

Material	Microscopic cross-sections (barns = 10^{-24} cm^2)		Macroscopic scattering cross-section (cm^{-3})	Macroscopic transport cross-section (cm^{-1})	Transport mean free path (cm)	Extropolated length d (cm)	# Atoms per cm^3	Macroscopic absorption cross-section (cm^{-1})	Diffusion coefficient	Diffusion length L (cm)
	Scattering	Absorption								
Carbon	5,559	0.00353	0.3679	0.3474	2.88	2.04	6.62E+22	0.0002	0.9588	64.06
Hydrogen	82.03	0.3326	0.3210	0.1070	9.34	6.64	3.91E+21	0.0013	3.0775	48.62
Nitrogen	11.53	1.91	0.0123	0.0117	85.32	60.61	1.07E+21	0.0020	24.2261	109.01
Coal	n/a	n/a	0.7012	0.4662	2.15	1.52	7.12E+22	0.0036	0.7096	14.09

Figure 2 plots equation (10) for the values of d and L in table 1, and a sphere of radius R = 100 m. Note the logarithmic scales on both axes. Figure 3 expands the region near the edge of the sphere with a linear scale for both axes. These show that the flux remains essentially constant at its value at r = 0 until r is within a few multiples of the diffusion length of the surface of the sphere, when it begins to drop off, eventually decreasing to zero at the extrapolated length beyond the edge of the sphere. Since the spatial impact of any given fission is limited by the mean free transport length and the diffusion length for the emitted neutrons, both of which are quite small for coal, the interior flux is uniform. The reduction in flux near the edge of the sphere only happens when the source of the neutrons is a few diffusion lengths from the edge, when some of the neutrons start to leak out of the sphere. As the source of the neutrons gets closer to the edge, the higher the probability of leakage.

Thus, for the coal, except near the very edge of the formation, the flux, in neutrons per sec/cm^2, is

$$\Phi = \frac{S}{\Sigma_t} \tag{11}$$

Substituting this in (6) results in the number of neutron absorptions per second per cm^3 being given by

$$\frac{S}{\Sigma_t}\sigma_a N_N \tag{12}$$

where S is the rate of neutron production per cm^3, σ_a is the neutron absorption cross-section of ^{14}N in cm^2, N_N is the number of ^{14}N atoms per cm^3 exposed to the neutron flux, and Σ_t is the macroscopic scattering cross-section for coal.

The rate of neutron production per cm^3 is

$$S = 2.07\lambda_f N_{U238} \tag{13}$$

so the steady-state rate of formation of ^{14}C from the spontaneous fission of ^{238}U is

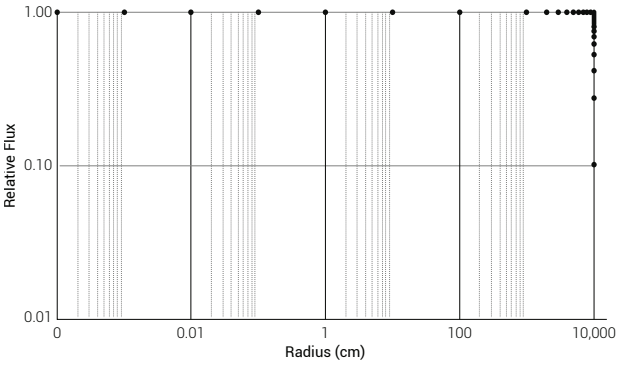

Figure 2. Relative neutron flux as a function of radius for a sphere of coal with radius 100 m and other parameters as per table 1

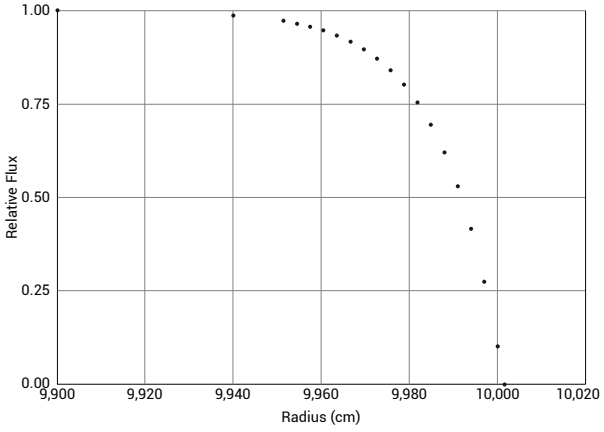

Figure 3. Plot of relative neutron flux vs radius near the edge of a sphere of coal of radius 100 m

$$\begin{aligned}\lambda_A N_A &= \frac{2.07\lambda_f N_{U238}\sigma_a N_{N14}}{\Sigma_t} \\ &= \frac{2.07\lambda_f \sigma_a N_{N14}}{\Sigma_t} N_{U238} \\ &= \lambda_U N_{U238}\end{aligned} \tag{14}$$

where λ_U is the effective 'decay' rate of ^{238}U to ^{14}C. Substituting this in (4) with $N_B = N_{C14}$ and rearranging gives

$$N_{U238} = \frac{\Sigma_t \lambda_\beta N_{C14}}{2.07 \lambda_f \sigma_a N_{N14}} \quad (15)$$

where N_{U238}, N_{C14} and N_{N14} are, respectively, the number of ^{238}U, ^{14}C, and ^{14}N atoms per cm³, λ_f is the 'decay' rate for the beta decay of ^{14}C to ^{14}N, λ_f is the 'decay' rate for the spontaneous fission of ^{238}U, σ_a is the thermal neutron absorption cross-section for ^{14}N, and Σ_t is the macroscopic scattering cross-section of the coal. Dividing the numerator and denominator on the righthand side by N_{C12}, the number of ^{12}C atoms per cm³, gives

$$N_{U238} = \frac{\Sigma_t \lambda_\beta \left(\frac{N_{C14}}{N_{C12}} \right)}{2.07 \lambda_f \sigma_a \left(\frac{N_{N14}}{N_{C12}} \right)} \quad (16)$$

$\frac{N_{N14}}{N_{C12}}$ is the ratio of ^{14}C to ^{12}C in the coal, which is the actual AMS measurement in pMC, and $\frac{N_{N14}}{N_{C12}}$ is, effectively, the ratio of the amount of nitrogen in the coal to the amount of carbon in the coal. Thus,

$$N_{U238} = \frac{\Sigma_t \lambda_\beta \left(\frac{pMC}{100} MC \right)}{2.07 \lambda_f \sigma_a \left(\frac{N_{N14}}{N_{C12}} \right)} \quad (17)$$

As noted earlier, the composition of coal varies as C: 75–90%, H: 4.5–5.5%, N:1–1.5%, so the maximum value for N_N/N_{C12} (i.e. the ratio that would provide the largest amount of ^{14}N, and therefore the highest rate of ^{14}C production) would be 1.5/75 = 0.02.

Thus, for the situation under discussion, pMC = 0.235% = 0.00235, MC = 1.2×10^{-12} atoms of ^{14}C to atoms of ^{12}C,[21,22] $\lambda_\beta = \ln(2)/(5{,}700 \times 365 \times 24 \times 3{,}600) = 3.856 \times 10^{-12}$ per second, $\lambda_f = \ln(2)/(8.27 \times 10^{15} \times 365 \times 24 \times 3{,}600) = 2.66 \times 10^{-24}$ per second, $\sigma_a = 1.91 \times 10^{-24}$ cm²,[23] $\frac{N_{N14}}{N_{C12}} = 0.02$, and $\Sigma_t = 0.7012$ (table 1). Solving for N_{U238} gives $N_{U238} = 3.6 \times 10^{22}$ atoms per cm³.

Since a mole of ^{238}U consists of 6.022×10^{23} atoms, this corresponds to approximately 0.06 moles of ^{238}U per cm³. A mole of ^{238}U weighs very nearly 238 g. Therefore, 0.06 moles of ^{238}U would weigh 14.3 g, which would mean that the density of the 'coal' would be at least 14.3 g/cm³. However, the bulk density of coal is about 1.35 g/cm³. This means that the coal does not contain the amount of ^{238}U required to produce the observed number of ^{14}C atoms.

Moreover, uranium generally occurs in the form of uraninite, a.k.a. pitchblende, which is mainly UO_2. Thus 0.06 moles of uranium implies 0.06 moles of uraninite. Since the molecular weight of oxygen is essentially 16 g, the molecular weight of uraninite is 270 g. Thus a 1 cm³ volume containing 0.06 moles of uraninite would have a density 16.2 g/cm³. However, the density of pure uraninite is only about 10.8 g/cm³. So, material containing sufficient uranium atoms to sustain the amount of ^{14}C observed in the coal would need to be more than 100% pure uraninite.

Alternately, given the measured density of coal, 1 cm³ of coal, if pure carbon, would contain 0.11 moles of carbon. Putting this amount of carbon with the required amount of ^{238}U would mean that the 'coal' would be about 35% ^{238}U (0.06/(0.06 + 0.11)). The richest uranium deposits in the world (at Cigar Lake and McArthur River, both in the Athabaskan Basin in Canada) have ore grades (uranium concentrations) of 18% and 17% respectively. Thus, if the levels of ^{14}C measured in the coal were the result of the presence of uranium, the 'coal' would more correctly be called 'top-rate uranium ore' and mined for its uranium content rather than its coal content.

Finally, one can take the observed concentration of uranium in coal and use this to calculate the number of ^{14}C atoms that would be present once secular equilibrium had been achieved and compare this to the observed concentration of ^{14}C in the coal. Coal contains about 1–2 ppm uranium.[24] Thus, per cm³ of coal, there will be about

$$N_{U238} = N_{C12} 10^{-6} \text{ atoms of uranium} \quad (18)$$

These will be producing $2.07 \lambda_f N_{C12} 10^{-6}$ neutrons per second from spontaneous fission, resulting in a neutron flux

$$\Phi = \frac{2.07 \lambda_f N_{C12} 10^{-6}}{\Sigma_t} \text{ neutrons per second per cm}^2 .$$

This means that the number of ^{14}C atoms being produced per second per cm³ would be

$$N_{C14} = \frac{2.07 \lambda_f N_{C12} 10^{-6} \sigma_a \left(\frac{N_{N14}}{N_{C12}} \right)}{\Sigma_t} \quad (19)$$

Setting this equal to the rate of decay of ^{14}C (i.e. assuming secular equilibrium) gives

$$\lambda_\beta N_{C14} = \frac{2.07 \lambda_f N_{C12} 10^{-6} \sigma_a \left(\frac{N_{N14}}{N_{C12}} \right)}{\Sigma_t} \quad (20)$$

Rearranging gives

$$\lambda_\beta N_{C14} = \frac{2.07 \lambda_f 10^{-6} \sigma_a \left(\frac{N_{N14}}{N_{C12}} \right)}{\lambda_\beta \Sigma_t} \quad (21)$$

Using the preceding values for the various parameters gives the expected ratio of ^{14}C atoms to ^{12}C atoms as

$$\frac{N_{C14}}{N_{C12}} = 7.9 * 10^{-44} \quad (22)$$

which is about 6.6×10^{-30} pMC as compared to the measured 0.235 pMC.

From any of these perspectives, the claim that the ^{238}U content of coal would produce the observed levels of ^{14}C fails.

Effect from a uranium deposit adjacent to the coal

For the case of the ^{14}C being generated by an adjacent uranium ore body, a similar analysis can be done but with the uranium uniformly distributed within some different material than coal that is outside, but adjacent to, the coal seam.

Typically, uranium is found as uraninite (UO_2) distributed in some other rock. The richest uranium ore bodies are in the Athabaskan Basin which is largely sandstone. Sandstone is generally composed of feldspar, of which there are several variants. Assuming orthoclase feldspar ($NaAlSi_3O_8$), the macroscopic scattering cross-section is 0.19 cm^{-1} vs 0.70 cm^{-1} for coal, the transport mean free path is 2.15 cm vs 5.46 cm for coal, the diffusion length is 4 cm vs 14 cm for coal, and the extrapolated path length is 3.9 cm vs 1.5 cm for coal.

Thus, as with coal, the neutron flux in the feldspar matrix is determined by a relatively small volume and the neutrons do not travel overly far from their source. This means that only those from a relatively small portion of the uranium deposit immediately adjacent to the coal would penetrate the coal. Because the transport mean free path and diffusion length in the coal is also quite small, only the nitrogen in a relatively thin layer of the coal immediately adjacent to the uranium deposit would be exposed to this uranium flux. Furthermore, the neutron flux entering the coal would only be a portion of that generated in the uranium ore, since at least half the neutrons would be heading away from the coal. Since the concentration of uranium required to sustain the observed levels of ^{14}C when the uranium is uniformly mixed throughout the coal is already well above that of the richest uranium ore, clearly this explanation also fails.

Empirical neutron density measurements

Additionally, this issue can be analyzed using the empirically measured neutron density at depth. As reported in the RATE paper, Kuhn *et al.*[25] measured thermal neutron densities of 1.1–33 neutrons per cm^3 per year ($3.49 \times 10^{-8} - 1.05 \times 10^{-6}$ neutrons per cm^3 per sec) in mines deeper than 800 m. More recently, Šrámek *et al.*[26] have used a more theoretical approach to calculate subterranean neutron densities in the range of 10^{-3} to10^{-6} neutrons per kilogram of rock per second. Using 2.7 gm/cm^3 as the density of the continental crust results in a neutron density of 2.7×10^{-9} to 2.7×10^{-6} neutrons per cm^3 per second. Using the geometric mean of these values gives an 'empirical' neutron density of approximately 1.26×10^{-7} neutrons per cm^3 per second regardless of source.

Using this for S in equation 14 and setting this equal to the rate of decay of ^{14}C (assuming secular equilibrium), rearranging and dividing both sides by N_{C12} gives

$$\frac{N_{C14}}{N_{C12}} = \frac{S\sigma_a}{\Sigma_l \lambda_f} = \frac{N_{N14}}{N_{C12}} .$$

Substituting previously defined values gives

$$\frac{N_{C14}}{N_{C14}} = 1.48 * 10^{-9} = 0.000000148\, pMC .$$

Thus, using empirically determined subterranean neutron densities, regardless of the source of these neutrons, generates a level of ^{14}C to ^{12}C that is orders of magnitude less than the measured levels.

Explanation within a biblical historical timeframe

Since the measured ^{14}C in coal cannot be effectively explained within an old-earth paradigm, it is reasonable to ask how the results compare with the expectation based on the history derived from a plain reading of the Bible. Rotta discusses this from the perspective that the atmospheric ^{14}C-to-^{12}C ratio has not yet reached an equilibrium level and that, therefore, the fundamental assumption used in calculating radiocarbon 'ages' is incorrect. However, he does not try to reconcile the calculated ages with the biblically derived age. Therefore, what factors would affect the ^{14}C-to-^{12}C ratio during the pre-Flood period, and how would these reconcile these disparate ages?

Granting the usual explanation that coal formed from buried vegetation, from a biblical perspective, this burial would have happened during the global Flood. This means that all the vegetation that was buried would have been growing during some, or all, of the c. 1,650-year-long pre-Flood era. As such, the vegetation would all have about the same ^{14}C-to-^{12}C ratio, regardless of the geological layer in which it was buried. This precisely reflects the data.

Figure 4 shows the range of ^{14}C-to-^{12}C values for each sample at ±2σ, with the geological layers 'colour' coded. There is no distinction between any of the three samples, which represent widely separated layers (in depth and, supposedly, time). Qualitatively, the results match the expectations of the biblical framework.

Quantitatively, the transformation of the measured pMC to age requires the atmospheric ^{14}C-to-^{12}C ratio when the vegetation was growing. Normally this is assumed to be the same as today. However, this is arguably not the case. Since ^{14}C is not required to support life, it seems reasonable to assume God would not have created any. Thus, ^{14}C would have to build up in the atmosphere from cosmic ray collisions with nuclei in the upper atmosphere. Therefore, the more cosmic rays there are, the more ^{14}C is produced. In turn, the stronger the magnetic field, the smaller the cosmic ray flux. The earth's magnetic field has been measured to be decreasing by about 5% per century.[27] Projecting this back 45 and 60 centuries results in the earth's magnetic field being approximately 10 times stronger and 22 times stronger than it is today during the Flood and at creation, respectively. This implies a dramatically reduced cosmic ray flux with a correspondingly dramatic reduction in the ^{14}C production rate. Thus, it is reasonable to expect that the average level of ^{14}C in the atmosphere during the pre-Flood period would have been, perhaps, only 1⁄20 to 1⁄10 of what it is today.

Now consider the amount of ^{12}C in the atmosphere during that period. Again, if the coal has formed from vegetation that grew pre-Flood, the vast extent of coal fields around the planet would clearly indicate very extensive and luxuriant vegetation. This would require increased amounts of CO_2 in the atmosphere. For example, we know that an increase of 100% in the CO_2 concentration results in a 42% increase in (C3) plant growth.[28]

In the Cambrian ('dated' c. 500 Ma) atmospheric CO_2 levels were 20–25 times greater than today, decreasing to 4–5 times during the Jurassic period, followed by a steady decline to today's levels.[29,30] Moreover, the CO_2 levels in the Precambrian were similar to, or even higher than, those in the Phanerozoic rocks.[31] The 'ages', of course, reflect the uniformitarian interpretation. 500 Ma roughly corresponds to the Precambrian-Cambrian (PC-C) boundary; the Jurassic is supposedly the height of the 'age of the dinosaurs', and 49 Ma would correspond to about the middle of the Eocene layer.

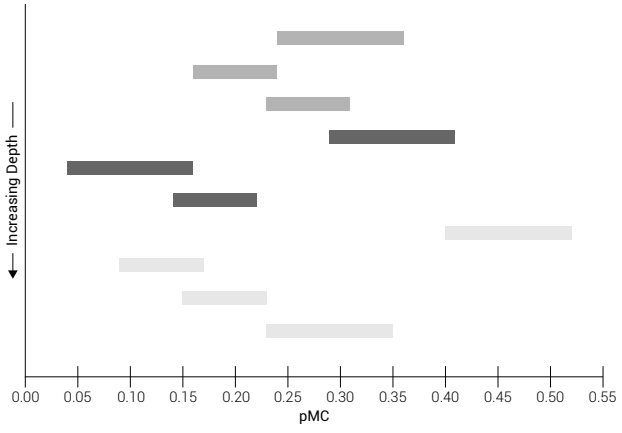

Figure 4. Range of pMC values for the ten coal samples at the ±2σ level with the three associated geological layers 'colour' coded

Some creationists consider the PC-C boundary to correspond to the pre-Flood boundary, while others consider it to be lower. Similarly, some consider the post-Flood boundary to correspond to the Cretaceous-Paleogene (K-Pg) boundary, while others consider it to be higher. Whichever view we take, the general picture is still the same. First, the pre-Flood atmospheric CO_2 level was likely at least 20 times today's level.[31,32] This would have reduced dramatically during the Flood, arriving at today's level some time shortly after the Flood.

Assuming, as above, that no ^{14}C was initially created and was building up only slowly in the atmosphere, the carbon in pre-Flood CO_2 would have been essentially all ^{12}C. Thus, the ratio of ^{14}C to ^{12}C prior to the Flood could have been as little as 1⁄400 to 1⁄200 of what it is today. This, of course, would mean that the calculated radiocarbon ages would all be dramatically reduced. If the ratio was 1⁄247 of today's value, then the calculated ages for the coal would be about 4,500 years, which is the timing of the global Flood.

Summary

In summary:

- The assertion that the levels of ^{14}C observed in coal samples could have been produced *in situ* by uranium, whether as a 'contaminant' in the coal or as an adjacent ore body, is not sustained:
  - the density of the resultant material required would be 50% denser than pure uraninite
  - the level of uranium that would be required would make the 'ore' the highest grade pitchblende in the world (31% vs 18% actual), and
  - the measured level of uranium in coal (1–3 ppm) is insufficient by many orders of magnitude to produce the observed concentration of ^{14}C in situ.
- The observed uniformity in ^{14}C level, regardless of geological layer of origin, is consistent with the biblical perspective that the vegetation in all layers had been growing at the same time in the pre-Flood world, and was all buried during the year-long global Flood.
- The measured radiometric ages are also consistent with the Bible when the ratio of ^{14}C to ^{12}C in the atmosphere at the time the vegetation was growing is adjusted to account for the effect of the earlier strength of the earth's magnetic field and the apparent higher amounts of atmospheric CO_2 in the pre-Flood period.

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2. Radioisotopes and the Age of The Earth. For an overview of this project see RATE group reveals exciting breakthroughs! creation.com/rate.
3. Baumgardner, ref. 1, p. 604.
4. Baumgardner, ref. 1, p. 598. 'pMC' stands for 'percent Modern Carbon', where 'Modern Carbon' is, effectively, the ^{14}C-to-^{12}C ratio in the atmosphere today.
5. Whereas the present discussion pertains to some particular coal samples, it should be noted that, as part of the project, the RATE paper listed 90 instances of non-zero AMS measurements of pMC in materials that were considered to be older than 100,000 years and, therefore, ^{14}C 'dead'. These were taken from papers published in the primary radiocarbon journals *Radiocarbon and Nuclear Instruments* and *Methods in Physics Research B* [Baumgardner, ref. 1, p. 592]. The reported values ranged from 0.014 to 0.71 pMC. Although these did not have a 'background' subtracted (since, because of their alleged age, they, themselves, were intended to be used as 'blanks' to measure the 'background'), fully 65 of them were greater than the 0.077 pMC used as the 'background' in the RATE coal measurements and 61 of the measurements were greater, even, than 0.077+0.005 pMC, which would be a reasonable upper limit for the so-called 'background' if the experimental uncertainty in the 'background' is included.
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Was evolution invented by Greek philosophers?

Benno Zuiddam

Despite claims of creationists and evolutionists to the contrary, a philological examination of the extant writings of the Greek philosophers Thales, Anaximander, and Empedocles shows that there is no textual-historical basis to credit the pre-Socratic philosophers with developing a theory of evolution.

With the rise of the evolutionary paradigm in Western education, tracing our present thinking about evolution back to the Greek philosophers has become a popular idea. For instance, visitors to the Museum of Palaeontology at the University of California are greeted with the statement: "Evolutionary theory begins with the Ionian philosopher Anaximander (ca 611–546 BCE)."[1] Prominent creationists approve: "Organic evolution was first taught by the Greeks at least as early as the 7th century BC."[2]

This, at least, seems to be an issue that some creationists and evolutionists agree on.

Both creationists and evolutionists (though not classical scholars)[3] have proposed that evolutionism goes back to ancient Greece. The philosophers who would have advocated this all belong to the period before Socrates, Plato, and Aristotle, and are therefore referred to as the "pre-Socratics" in philosophy.

From a creationist perspective Dr Bergman summarizes the arguments in the following way:

> "One of the first evolutionary theories was proposed by Thales of Miletus (640–546 BC) in the province of Ionia on the coast near Greece. He was also evidently the first person to advance the idea that life first originated in water …
>
> "… One of Thales' students, Anaximander (611–547 BC), developed these ideas further, concluding that humans evolved from fish or fishlike forms. These fish-men eventually cast off their scaly skin and moved to dry land where they have been ever since.
>
> "The Greek philosopher Empedocles (493–435 BC), often called the father of evolutionary naturalism, argued that chance alone 'was responsible for the entire process of the evolution of simple matter into modern humankind. Empedocles concluded that spontaneous generation fully explained the origin of life, and he also taught that all living organism types gradually evolved by the process of trial-and-error recombinations of animal parts. He also believed that natural selection was the primary mechanism of evolution, the fittest being more likely to survive to pass their traits on to their offspring. In short, Empedocles' pre-Darwin 'survival-of-the-fittest' theory taught that life evolved by pruning the less-fit life forms—i.e. the merciless destruction of the weaker animals and plants. Unfortunately, many early Greek manuscripts have been lost, but the texts that survive provide enough details to determine with some accuracy what the ancient Greeks believed."[4]

Is this perception correct? More specifically in terms of a research question for this paper: *Did some of the pre-Socratic philosophers teach a form of evolution?* The thesis that this article seeks to prove is that neither Thales, nor Anaximander, nor Empedocles proposed a theory that included the vital ingredient of evolution, development of one species into the next. Arguing from the available Greek primary and secondary sources, using a philological and historical method, this paper will show that there is no evidence that Thales proposed one of the first evolutionary theories or that Anaximander taught that humans *evolved* from fish. It will also dispute the factual basis in the ancient sources to refer to Empedocles as "the father of evolutionary naturalism". In short, this contribution disputes that there is any evidence for evolution, in the Neo-Darwinist sense or otherwise, in the extant Greek texts of these early philosophers.

Thales of Miletus

Thales (c. 620–546 BC) was credited with the view that water is the universal primary substance,[5] and likewise with the doctrine that the world is animate (τὸν κόσμον ἔμψυχον) and full of powerful spirits or gods (δαιμόνων).[6] This indicates that Thales' worldview was not naturalistic but thoroughly spiritual. Aristotle confirms this (*De Anima* II/411 a7–8). For Thales possibly every object and certainly every living being had an essential spirit or god behind it, which was represented by its incidence.

Henry Osborn, one of the first to point to the Greek philosophers for evolution, was mistaken in his assertion that Thales began to teach "evolution as a natural explanation of

the higher forms of life".[7] There is no evidence for this, only a loose point of agreement with neo-Darwinism in that the origins of life included water,[8] but this does not make Thales a naturalist, let alone an evolutionist. It merely articulates that modern evolutionist thinking has incorporated his idea of origin in or with water. The Greek philosopher merely saw water as a permanent principle, an element that remains while other things come and go. Thales believed that water always persists and that it is the basis from which all other things are generated.[9] His beliefs were reinforced by his observation that all living things on this planet seemed to depend on water. He also thought of the earth as floating on water.[10]According to Aristotle, Thales was evidently *not* the first person to suggest water as original principle:

> "There are some who think that the men of very ancient times, long before the present era, who first speculated about the gods, also held this same opinion about the primary entity (i.e. water). For they represented Oceanus and Tethys to be the parents of creation, and the oath of the gods to be by water—Styx, as they call it. Now what is most ancient is most revered, and what is most revered is what we swear by."[11]

In sum, the available early sources show that Thales merely proposed that the origin of life is connected with water as a crucial element. This might well be visualized with a picture of the sea as bedrock for life, like the imagery of his pupil Anaximander advocates. The only agreement with the theory of evolution is the original connection of life-forms with water as an element or locality. However, in a similar way a connection between Thales and Genesis 1:2 could be argued: "the Spirit of God moved upon the face of the waters". Thales' association of the origin of life-forms with water also sits comfortably with theories that very much oppose evolution. In other words, what Thales says about water is irrelevant for the essential part of evolution, its operating process or method. There is no evidence of development from one species into another with Thales. The Greek philosopher did not provide any descriptions of the development of life that suggest this.

Anaximander of Miletus

Anaximander (c. 610–546 BC) was a disciple of Thales. He was a brilliant scholar and one of the first to envisage the earth hanging free and unsupported in space, while planets completed circular orbits. He is also credited with the idea of a cylinder-shaped Earth, which is spherical and flat at the same time and floats unsupported as the centre of the universe.[12]

The idea that Anaximander held a proto-theory of evolution is based on his view on the origin of life in mud, which is subsequently interpreted in terms of prebiotic soup.[13] Darwin, albeit tentatively, also sought the origin of life in a 'warm little pond'.[14]

> "Anaximander said that the first living creatures were born in moisture, enclosed in thorny barks and that as their age increased they came forth on to the drier part and, when the bark had broken off, they lived a different kind of life for a short time (Aetius, V, 19)."[15]

Although the author of this quotation, Aetius of Antioch, is used to prove this particular view of Anaximander, his work is not particularly well attested. The reference to 'Aetius' is irregular, as no works of his remain. The actual source is *Physical and Moral Extracts*, written by the fifth-century theologian John Stobaeus. Opinion is divided whether Aetius himself lived in the second or the first century before Christ. In any event this was hundreds of years after Anaximander whose alleged views he describes. Consequently the evidence is rather indirect: Stobaeus quoting Aetius on Anaximander, with a full millennium distance from the primary source.

A second source for Anaximander's views is also problematic: a pseudo-graphic author who claimed to be writing as the first century philosopher Plutarch.

Figure 1. *School of Athens* by Rafael

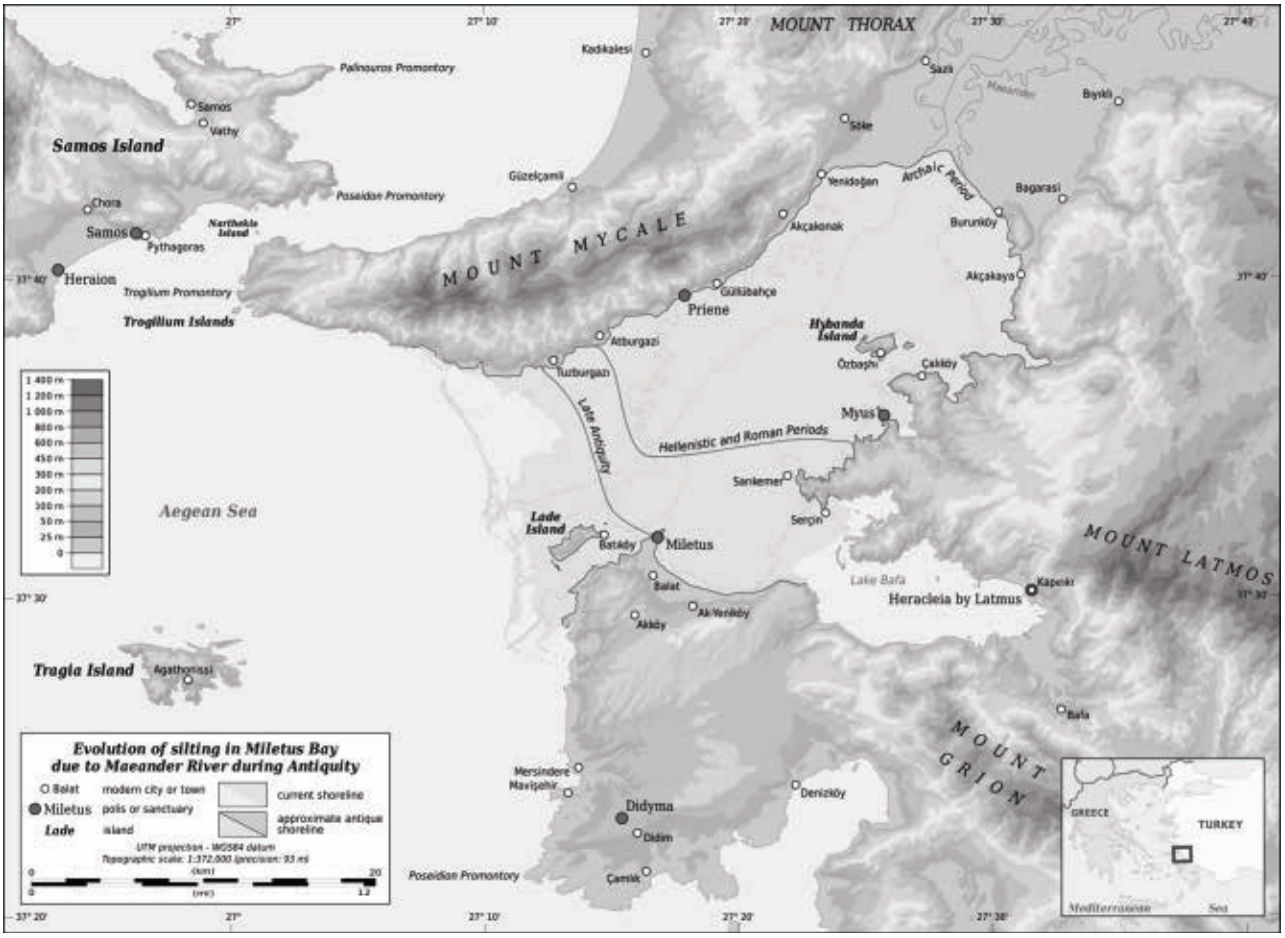

Figure 2. Miletus in ancient Greece (by Eric Gaba)

> "Further he [Anaximander] says that in the beginning man was born from creatures of a different kind; because other creatures are soon self-supporting, but man alone needs prolonged nursing. For this reason he would not have survived if this had been his original form."[16]

A complicating factor, which invites some scepticism, is the fact that there are important parallel passages in Stobaeus and Pseudo-Plutarch.[17] Possibly Pseudo-Plutarch is a reasonably accurate source still, because he drew from books that were known at the time and wished to be regarded as genuine Plutarch. Otherwise he does not contradict material found in the real Plutarch, and some of his statements are also found in Aristotle and Hippolytus of Rome (AD 170–235). For example, the idea that (unlike his master Thales) Anaximander thought of *air* as the first principle of all things living. Pseudo-Plutarch adds that he personally considers mere air unlikely as first principle, because of the perceived lack of an operating cause. Just like the mere presence of silver is insufficient for a cup to emerge, but that it also needs a creative force, a silversmith. According to Pseudo-Plutarch the same would be true for any other material like wood or brass.[18] While Pseudo-Plutarch adds his own thoughts, his description of Anaximander's view of water as first principle is undisputed and is also found in Aristotle and the church father Hippolytus.[19]

If Anaximander was true to the teachings of his master Thales in other respects, the demons or gods that filled the cosmos[20] should be taken as an operating cause in Anaximander's thinking. If so, his worldviews were not secular and there is no need to explain his religious language and imagery as a mere vehicle of expression of his times.

Pseudo-Plutarch indicated that air is an important principle in Anaximander's thinking. He was probably the first person in Greek thinking to whom the pneumatic theory of the soul can be attributed. Earlier authors, like Homer, considered that the essence of the soul was in the blood, but Anaximander thought that the soul was spiritual, or airy in nature.[21] Late evidence for this comes from (the genuine) Plutarch's *Table Talk*,[22] which is part of his *Moralia* collection. On the basis of one of its discussions, Anaximander is credited with humanity's evolutionary

development from fishes. Plutarch relates the following (*Quaest. Conv.* 8.8):

> "To this Nestor subjoining said: But, sir, of my citizens, as of the Megarians in the proverb, you make no account; although you have often heard me say that our priests of Neptune (whom we call Hieromnemons) never eat fish. For Neptune himself is called the Generator. And the race of Hellen sacrificed to Neptune as the first father, imagining, as likewise the Syrians did, that man rose from a liquid substance. And therefore they worship a fish as of the same production and breeding with themselves, in this matter being more happy in their philosophy than Anaximander; for he says that fish and men were not produced in the same substances, but that men were first produced in fishes, and, when they were grown up and able to help themselves, were thrown out, and so lived upon the land. Therefore, as the fire devours its parents, that is, the matter out of which it was first kindled, so Anaximander, asserting that fish were our common parents, condemneth our feeding on them. [LCL424]"[23]

Writing a century later, Hippolytus confirms that this idea was ascribed to Anaximander. The church father gives a summary in his *Refutation of all Heresies:*

> "And [Anaximander declared] that animals are produced (in moisture) by evaporation from the sun. And that man was, originally, similar to a different animal, that is, a fish."[24]

Importantly, Anaximander did not see water or moisture as the first eternal element, but air. In this passage it is the hot air overcoming water by means of evaporation (ἐξατμιζομένου) that produces animals.[25] The words about the animals rising from moisture or mud (εξ ύγροῦ) have their background in the Greek theory of abiogenesis, or spontaneous generation of life from an organic matter. For instance, from ancient observation it seemed that fleas originated from dust and maggots from cadavers. Aristotle was one of the first to teach this theory,[26] which prevailed until 1859 when Louis Pasteur disproved it.[27]

Even if the pertinent issue of abiogenesis is set aside, the question remains whether these passages actually teach that humans evolved from fish or fishlike forms. They probably do not. Even Hippolytus (who disagreed with Anaximander 700 years later) does not accuse him of promoting the view that men *were* initially fish, only that they 'nearly resembled' (παραπλήσιον) fish. In other words, mankind was in a different state, but not a different species. Plutarch, who wrote earlier, makes a clear distinction between the fish and the humans they contain. As Hippolytus writes later and only summarizes, he should be read in the light of Plutarch. Consequently, from a philological and literary-historical point of view, Anaximander's idea of fish as our common parents[28] points to hosts rather than to a form of evolution.

At best, the text teaches development or adaptation *within* a species. Perhaps the comparison with the development of a butterfly applies. The fish only serve as cocoons or eggs to protect and nourish the humans until they are ready to tackle the next stage of life. To claim that Anaximander taught a form of Darwinian evolution is not warranted by the text. Even Kočandrle and Kleisner, who otherwise have the Greek philosophers 'foreshadow' Darwinism, as they call it, acknowledge that a literal interpretation of the text does not point to evolution:

> "If this is more than just a reference to the origin of life in a moist environment, the entire concept may be most clearly described in Plutarch. He places the birth of humans quite unequivocally into fish, in particular the viviparous sharks (though here, the manuscript was emended). People are then almost in a position of the biblical Jonah [figure 3]. If we were to read Plutarch literally, man grew in fish until reaching a level of independence. The story would thus deal not with the development of humans from other creatures but with a description of the growth of the first individual from a species that cannot take care of itself after birth."[29]

Figure 3. *Jonas en de walvis* by Pieter Lastman, 1621

Kočandrles' and Kleisner acknowledge that Anaximander does not teach that humans evolved from fish or fishlike forms. With him they are humans to begin with. Their reference to Jonah is also helpful, as the big fish served as a safe environment where the prophet was protected against the tempest and sea (Jonah 1:17). In the stories about Anaximander's teachings, the humans leave the fish once they are ready, similar to a baby leaving the amniotic fluid of the placenta behind once it is ready to live in this world independently.

In no uncertain terms, Kočandrle and Kleisner conclude that Anaximander did not teach evolution and that he did not believe in a common descent of all species:

> "The idea of evolution by natural selection was certainly completely foreign to Anaximander. One can suppose that Anaximander's interest stemmed from a desire to explain arrival of first living creatures or, in particular, of the first individuals of each species. Even so, one can claim that his theory was, in principle, open to evolutionary ideas."[30]

Gregory agrees: "There is nothing in Anaximander to suggest survival of the fittest or adaptation to the environment."[31] Another important matter is that while Anaximander was a naturalist,[32] he firmly believed that all of the cosmos was governed by moral law and not by chance.[33] World systems come into being and perish again into the infinite as a matter of penalty and retribution to make up for injustice.[34] Human life is governed by similar principles.[35] Anaximander believed that just as a well-ordered government sees that theft is punished, so the order of nature is such that no considerable imbalance can last indefinitely.[36] Whilst Anaximander teaches a secular, linear, and progressive conception of history, it is through mankind's observance of morality that the world advances.

> "Anaximander was the first to believe that if there is a 'golden age', this age is not forever lost in some distant past as it was in mythical accounts, but perfectly achievable in the future, that is, on condition that man realizes that social order like natural order must be based on an equilibrium of rights and obligations, that mutually hostile opposites are nonetheless equals."[37]

These are not completely new observations. As early as 1954, Professor Loenen cautioned that post-Darwinian suppositions should not be imported into the work of ancient authors. After a detailed study of all the concepts involved, he summarizes his findings on Anaximander's alleged evolutionism as follows:

> "(1) The central idea of modern evolutionism is the conception that the higher species developed from the lower ones. With Anaximander an evolution of species is out of the question. (2) Modern evolutionism explains evolution by natural selection and (or) adaptation to environment. With Anaximander there is no indication for the idea of natural selection, whereas the adaptation to environment which he, in a sense, probably accepted, had no consequences as to the biological structure of the animals, but only as to their habits of living. (3) Evolutionism finds its arguments in the field of biology and palaeontology. Anaximander, on the contrary, based his strange theory on the idea that all organic life originated in the sea. (4) The idea of abiogenesis which was undoubtedly basic for Anaximander, is not an evolutionist theory, at least as far as modern evolutionism keeps within the bounds of biological science. We may safely[38] state that no biologist is convinced that abiogenesis has been proved by purely scientific arguments. Those biologists who take an abiogenesis for granted know very well that this is a logical postulate, i.e. a philosophical conception. On account of the principle *omne vivum a vivo*, which has been established scientifically, one would be even more justified in stating the contrary. So even on this point Anaximander is not a precursor of modern evolutionism."[39]

Summarized, there is no evidence in Anaximander for the central concept of evolution that, at a biological level, higher species developed from lower ones. Even biological adaptation seems absent from his thinking.

Empedocles of Acagras

The third ancient candidate whom Bergman and others put forward as teaching evolutionary theory is the Greek philosopher Empedocles (c. 493–435 BC). He lived on the isle of Sicily and is known for adding earth as a fourth primary element to air, water, and fire.[40]

But is Empedocles the 'father of evolutionary naturalism'? This thesis implies that Empedocles not only taught evolution, but also as an unguided process. If one considers the latter first, it immediately becomes clear that this runs against all the available evidence about his worldview. Empedocles was not a secularist at all. He was a vegetarian for religious reasons who also believed in some form of reincarnation. Not only did he accept the transmigration of souls as true, but he also regarded himself as a god who was banished to Earth for 'three times countless years' for committing the sin of eating meat. His self-image included the conviction that he had achieved the most perfect of human states. To the public Empedocles wished to confirm the rumour that he had already become a god.[41] Otherwise the philosopher was known as a diviner and an oracular medium on behalf of the gods. He was also a magician and claimed to be able, possibly with the use of pharmacy, to fully control the weather (wind and rain) and also to have returned a dead man from Hades.[42] He allegedly

kept the body of a woman in a trance for 30 days without breathing or pulsation for the duration. Empedocles in his own words:

> "I go about among you an immortal god, no more a mortal, so honoured of all, as is meet, crowned with fillets and flowery garlands. Straightaway as soon as I enter with these, men and women, into flourishing towns, I am reverenced and tens of thousands follow, to learn where is the path which leads to welfare, some desirous of oracles, others suffering from all kinds of diseases, desiring to hear a message of healing."[43]

Empedocles confirmed his (poly) theistic worldview with his teachings: "Blessed is the man who has gained the riches of divine wisdom; wretched he who has a dim opinion of the gods in his heart."[44] The philosopher was principally a proponent of intelligent design by the gods. He even warned his readers that they should not be deceived by naturalism, but that there are divine painters who are responsible for the material reality of this world. If Burnett's interpretation is correct, Empedocles even argues that this should be believed on the basis of divine revelation (θεοῦ πάρα μῦθον ἀκούσας)!

> "As painters, men well taught by wisdom in the practice of their art, decorate temple offerings when they take in their hands pigments of various colours, and after fitting them in close combination—more of some and less of others—they produce from them shapes resembling all things, creating trees and men and women, animals and birds and water-nourished fish, and long-lived gods too, highest in honour; so let not error convince you in your mind that there is any other source for the countless perishables that are seen, but know this clearly, since the account you have heard is divinely revealed."[45]

By now it should be evident that Empedocles wasn't a naturalist, so evolutionary naturalism should be ruled out, if only for that reason. However, as a polytheist, did he teach evolution? Empedocles proposed that the universe was governed by a continued interplay of the forces Love and Strife, which may be interpreted as attraction and repulsion.[46] These worked upon the primary elements and continue to do so even in organisms like the human body. This seems to point into the direction of change through adaptation and survival of the fittest. While Love and Strife may well function as a Hegelian principle, this is probably where the comparison with evolution ends, because with Empedocles these forces are moral in character. He calls Love 'soft', 'immortal', and 'blameless'.

The first appearance of creatures in this world is because they have lost their immortality because of their exposure to love in the vortex of worlds and circumstances. Unlike their previous abode, Earth is mortal in character. It is important to note that Empedocles does not describe creation, but manifestation. It is not that these creatures did not exist before, but that they had been immortal in a different reality where they had the misfortune to be touched by a soft and constant stream of immortal love.[47] Empedocles describes a fall and change in status. This is rather a Greek equivalent of the fall of mankind in Genesis 3, not of the creation story of Genesis 1. For Empedocles the major challenge is to achieve the original immortality again after the shattering experience of the fall.

Empedocles does not describe the results of evolution when he speaks about creatures with countless hands, oxen with human faces, etc.[48] For him this was the limited aftermath of the fall into mortality, a phase of, sometimes literally, picking up the pieces after the great literal mix-up. It was this great mix-up and not a creation process that caused solitary limbs to wander seeking for union.[49] In the best of circumstances not a concept readily associated with natural selection in the Darwinian sense, but for Empedocles this is a restorative and not a creative process. Furthermore, he insisted that this reassembly into 'proper' species was essentially a divine and not a mere natural process: "But, as divinity was mingled still further with divinity, these things joined together as each might chance, and many other things besides them continually arose."[50]

It is against this background that Aristotle's (*Physics* II) insight on Empedocles should be read:

> "And so with all other organs that seem to embody a purpose. In cases where a coincidence brought about such a combination as might have been arranged on

Table 1. A visual summary of the views of the pre-Socratics

	Evolution			
	Naturalistic	Darwinian	Super-Naturalistic	Theistic
Thales	none	none	none	none
Anaximander	none	none	none	none
Empedocles	none	none	none	none

	Biological adaption	**Worldview**
Thales	none	super-naturalistic
Anaximander	none or inconclusive	super-naturalistic
Empedocles	none	super-naturalistic

> purpose, the creatures, it is urged, having been suitably formed by the operation of chance, survived; otherwise they perished, and still perish."[51]

This merely describes the adaptation of a species to changing circumstances. Indeed, this is also an important element in Darwin's theory, but hardly exclusively so. Adaptation of species may be noticed by any keen observer and Empedocles should be credited for this; but this does not make him a proto-Darwinian. Adaptation of species is not unique to Darwinism, but shared by scholars of any persuasion.

For Empedocles the 'trial-and-error recombinations' belong to the initial phase of chaos after the fall into mortality, but when everything is sorted and recovered things continued as 'normal'. This should not be confused with 'natural selection' in the Darwinian sense.[52] This phase of alleged 'evolution' was not evolutionary in character, but the pieces of a puzzle coming back together again. For Empedocles this was not a random creation of life, but a divinely[53] guided recovery process from a fall into mortality.

In sum, there is no evolution in Empedocles, naturalistic or theistic. He merely proposed a temporal phase of discontinuity in the cosmos, to which mankind fell victim, but has since recovered from sufficiently to be in reach of immortality and divinity again.

In retrospect

This journey through the philosophies of Thales, Anaximander, and Empedocles shows that they did not propose any theory of evolution, naturalistic or otherwise. The available evidence even argues against the idea that the pre-Socratic philosophers advocated biological adaptation within a species. While it can be argued that their philosophies contain building blocks[54] that, as such, are also used in modern evolutionary concepts,[55] these 'blocks' are not unique to evolutionary concepts. Classical authors should be carefully considered in their textual, philosophical, and historical context.

References

1. www.ucmp.berkeley.edu/history/ancient.html
2. Bergman, J., Evolutionary naturalism: an ancient idea, *J. Creation* **15**(2):77–80, August 2001; p. 70.
3. The publications that are often relied on to establish a link between evolutionary theory and Greek philosophy were not written by classical scholars, but by doctors of science. This is particularly true for the foundational publication in this regard by Dr H.F. Osborn, *From the Greeks to Darwin*, MacMillan, London, 1908. Osborn's field was paleontology and anatomy. Interestingly, he was not a Darwinist and held the view that mutations and natural selection play no creative role in evolution and became a proponent of organic selection. In creationist circles the debate has been carried by natural scientists as well, and not by classicists or philosophers, e.g. Dr Bert Thompson's *History of Evolutionary Thought*, Star Bible & Tract Corp, Fort Worth 1982. (See also Bergman, ref. 2.)
4. answersingenesis.org/theory-of-evolution/evolutionary-naturalism-an-ancient-idea/
5. Aristotle, *Metaphysics* 1.983b.
6. Diogenes Laërtius, *Bίοι καὶ γνῶμαι* 1.27: Ἀρχὴν δὲ τῶν πάντων ὕδωρ ὑπεστήσατο, καὶ τὸν κόσμον ἔμψυχον καὶ δαιμόνων πλήρη.
7. Osborn, H.F., *From the Greeks to Darwin*, Macmillan, New York, p. 6, 1908.
8. Xenophanes (c. 576–480 BC) would later recognize fossils as remains of sea life, taking this as proof that the seas formerly covered the earth, and that water was the element from which the earth emerged. See Richard D. McKirahan, *Philosophy before Socrates: An introduction with texts and commentary*, 2nd edn, Hackett Publishing, Indianapolis, p.65, 2010. See also Hippolytus, *Refutation of All Heresies* 1.14.4–6.
9. Aristotle, *Met.* 983: ἀεὶ γὰρ εἶναί τινα φύσιν ἢ μίαν ἢ πλείους μιᾶς ἐξ ὧν γίγνεται τἆλλα σωζομένης ἐκείνης.
10. See Aristotle, *On the Heavens* 294a28, *Metaphysics* 983b20.
11. Aristotle, *Met.*, 983b: εἰσὶ δέ τινες οἳ καὶ τοὺς παμπαλαίους καὶ πολὺ πρὸ τῆς νῦν γενέσεως καὶ πρώτους θεολογήσαντας οὕτως οἴονται περὶ τῆς φύσεως ὑπολαβεῖν: Ὠκεανόν τε γὰρ καὶ Τηθὺν ἐποίησαν τῆς γενέσεως πατέρας, καὶ τὸν ὅρκον τῶν θεῶν ὕδωρ, τὴν καλουμένην ὑπ᾽ αὐτῶν Στύγα τῶν ποιητῶν: τιμιώτατον μὲν γὰρ τὸ πρεσβύτατον, ὅρκος δὲ τὸ τιμιώτατόν ἐστιν.
12. Couprie, D.L. and Pott, H.J., Imagining the Universe, *Apeiron: A Journal for Ancient Philosophy and Science* **35**(1):47–59, 2002; pp. 50–51. See also Couprie, D.L., *Heaven and earth in ancient Greek cosmology: from Thales to Heraclides Ponticus*, Springer, New York, 2011; p. 105: "In two texts it is said that the earth is like a column of stone, and in the third it is said that the earth is cylindrical-shaped, its height being one-third of its diameter."
13. See Gregory, A. Anaximander's Zoogony; in: Rossetto, M., Tsianikas, M., Couvalis, G., and Palaktsoglou, M. (Eds.), *Greek Research in Australia: Proceedings of the Eighth Biennial International Conference of Greek Studies, Flinders University June 2009,* Flinders University Department of Languages—Modern Greek, Adelaide, pp. 44–53, 2009.
14. Darwin also suggested the requirement of a large diversity of ammonia and phosphoric salts, and considered the presence of light, heat, and electricity a prerequisite. See Peretó, J., Bada, J.L., and Lazcano, A., Charles Darwin and the Origin of Life, *Origins of Life* and *Evolution of Biospheres* **39**(5):395–406, 2009.
15. Aetius v. 9.4: Ἀναξίμανδρος ἐν ὑγρῷ γεννησθῆναι τὰ πρῶτα ζῷα φλοιοῖς περιεχόμενα ἀκανθώδεσι, προβαινούσης δὲ τῆς ἡλικίας ἀποβαίνειν ἐπὶ τὸ ξηρότερον καὶ περιρρηγνυμένου τοῦ φλοιοῦ ἐπ᾽ ὀλίγον χρόνον μεταβιῶναι.
16. Pseudo-Plutarch, *Stromateis* 2. See Campbell, G. L., *The Oxford Handbook of Animals in Classical Thought and Life,* Oxford University Press, Oxford, p. 240, 2014.
17. See Gregory, A., *Anaximander: A re-assessment,* Bloomsbury Academic, Sydney, p. 52, 2016.
18. Ps. Plut. *Plac.* 1.3: ἀλλὰ καὶ τὸ ποιοῦν αἴτιον χρὴ ὑποτιθέναι οἷον ἄργυρος οὐκ ἀρκεῖ πρὸς τὸ ἔκπωμα γενέσθαι, ἂν μὴ καὶ τὸ ποιοῦν ᾖ, τουτέστιν ὁ ἀργυροκόπος ὁμοίως καὶ ἐπὶ τοῦ χαλκοῦ καὶ τοῦ ξύλου καὶ τῆς ἄλλης ὕλης.
19. Cf. Hippolytus, *Refutatio Omnium Haeresium* 1.6.
20. Diogenes Laërtius, *Bίοι καὶ γνῶμαι* 1.27: τὸν κόσμον ἔμψυχον καὶ δαιμόνων πλήρη.
21. Bosworth Burch, G., Anaximander, the first metaphysician, *The Review of Metaphysics* **3**(2):137–160, 1949; p. 157–158.
22. *Συμποσιακά—Quaestiones convivales.*
23. Plut. *Quaes. Conv.* 8.8.4: ὑπολαβὼν δ᾽ ὁ Νέστωρ 'τῶν δ᾽ ἐμῶν' ἔφη 'πολιτῶν ὥσπερ Μεγαρέων 32 οὐδεὶς λόγος: καίτοι πολλάκις ἀκήκοας ἐμοῦ λέγοντος, ὅτι ἀεὶ οἱ 33 τοῦ Ποσειδῶνος ἱερεῖς, οὓς ἱερομνήμονας καλοῦμεν, ἰχθῦς οὐκ ἐσθίουσιν ὁ γὰρ θεὸς λέγεται φυτάλμιος. οἱ δ᾽ ἀφ᾽ Ἕλληνος τοῦ παλαιοῦ καὶ πατρογενίῳ 34 Ποσειδῶνι θύουσιν, ἐκ τῆς ὑγρᾶς τὸν ἄνθρωπον οὐσίας φῦναι δοξάζοντες 35, ὡς καὶ Σύροι: διὸ καὶ σέβονται τὸν ἰχθῦν, ὡς ὁμογενῆ καὶ σύντροφον, ἐπιεικέστερον Ἀναξιμάνδρου 36 φιλοσοφοῦντες: οὐ γὰρ ἐν τοῖς αὐτοῖς ἐκεῖνος ἰχθῦς καὶ ἀνθρώπους, ἀλλ᾽ ἐν ἰχθύσιν ἐγγενέσθαι τὸ πρῶτον ἀνθρώπους ἀποφαίνεται, καὶ τραφέντας ὥσπερ οἱ γαλεοὶ 37 καὶ γενομένους ἱκανοὺς ἑαυτοῖς βοηθεῖν ἐκβῆναι τηνικαῦτα καὶ γῆς λαβέσθαι. καθάπερ οὖν τὸ πῦρ τὴν ὕλην, ἐξ ἧς ἀνήφθη, μητέρα καὶ πατέρ᾽ οὖσαν, ἤσθιεν, ὡς ὁ τὸν Κήυκος 38 γάμον εἰς τὰ 39 Ἡσιόδου παρεμβαλὼν εἴρηκεν οὕτως ὁ Ἀναξίμανδρος τῶν ἀνθρώπων πατέρα καὶ μητέρα κοινὸν ἀποφήνας τὸν ἰχθῦν διέβαλεν πρὸς τὴν βρῶσιν.
24. *Refutatio Omnium Haeresium* I.6.7: Τα δέ ζῷα γίνεσθαι <εξ ύγροῦ>, ἑξατμιζομένου ὑπό του ἡλίου, τὸν δὲ ἄνθρωπον ἑτέρῳ ζώῳ γεγονέναι—τουτέστιν ἰχθύι—παραπλήσιον κατ᾽ ἀρχάς. See Marcovich, M. (ed.), *Refutatio Omnium Haeresium*, Walter de Gruyter, Berlin, p. 65, 1986.

25. Hippolytus literally speaks about appearing or coming into a new state of being: γεγονέναι, from γίγνομαι.
26. Aristotle, History of the Animals, vol. 1 [LCL 438]. For a discussion of his views, see Lennox, J.G., *Aristotle's Philosophy of Biology: Studies in the origins of life science,* Cambridge University Press, Cambridge, pp. 232–235, 2001.
27. Since Pasteur, the idea of biogenesis or reproduction has prevailed. In chemistry and molecular biology the Latin saying *Omne vivum ex vivo* (all life is from life) applies. Although evolutionists at a metaphysical level require at least one event of abiogenesis, it is generally recognized that modern life does not arise from non-living material. E.g. the formation of cells requires other cells.
28. Literally: common father and mother (πατέρα καὶ μητέρα κοινὸν).
29. Kočandrle, R. and Kleisner, K., Evolution born of moisture: analogies and parallels between Anaximander's ideas on Origin of Life and man and later pre-Darwinian and Darwinian evolutionary concepts, *J. History of Biology* **46**(1): 103–124, 2013; p. 117.
30. Kočandrle and Kleisner, ref. 29, p. 118.
31. Gregory, A., ref. 13, p. 48.
32. Aristotle called Anaximander a naturalist, literally someone who seeks the explanation in the nature or material reality of things, e.g. *Phys*. III.4, 203b14.
33. In a historical sketch added to the sixth edition of the *Origin of Species,* Darwin admitted that his concept of chance was very different from the Greek philosophy of Aristotle's. Cf. Aristotle, *Physicae Auscultationes* II.8.2. For a fuller consideration of Aristotle's views on chance, see Dudley, J., *Aristotle's Concept of Chance: Accidents, cause, necessity, and determinism,* State University of New York Press, Albany, 2011.
34. Mansfeld, J., Anaximander's fragment: another attempt, *Phronesis* **56**(1):1–32, 2011; p. 8.
35. Hölscher, U., Anaximander und die Anfänge der Philosophie, *Hermes* **81**(3): 257–277, 1953; p. 271–272.
36. Matson, W.I., The naturalism of Anaximander, *The Review of Metaphysics* **6**(3): 387–395, 1953; p. 395.
37. Naddaf, G., On the origin of Anaximander's cosmological model, *J. History of Ideas* (59.1):1–28, 1998; p.28.
38. Original: safety.
39. Loenen, J.H., Was Anaximander an evolutionist? *Mnemosyne* **7**(3):215–232, 1954; pp. 231–232.
40. Aristotle, *Met.* 1.984a.
41. Diogenes, L., *Lives of Eminent Philosophers* VIII.2.29: βουλόμενον τὴν περὶ αὑτοῦ φήμην βεβαιῶσαι ὅτι γεγόνοι θεός.
42. See Diogenes, L., *Lives* VIII.2.11–12: φάρμακα δ' ὅσσα γεγᾶσι κακῶν καὶ γήραος ἄλκαρ πεύσῃ, ἐπεὶ μούνῳ σοὶ ἐγὼ κρανέω τάδε πάντα. παύσεις δ' ἀκαμάτων ἀνέμων μένος, οἵ τ' ἐπὶ γαῖαν ὀρνύμενοι πνοιαῖσι καταφθινύθουσιν ἄρουραν:11 καὶ πάλιν, ἢν ἐθέλῃσθα, παλίντιτα πνεύματ' ἐπάξεις: θήσεις δ' ἐξ ὄμβροιο κελαινοῦ καίριον αὐχμὸν ἀνθρώποις, θήσεις δὲ καὶ ἐξ αὐχμοῖο θερείου ῥεύματα δενδρεόθρεπτα, τά τ' αἰθέρι ναιήσονται, ἄξεις δ' ἐξ Ἀΐδαο καταφθιμένου μένος ἀνδρός.
43. Diogenes, L., *Lives* VIII.2.15: ἐγὼ δ' ὑμῖν θεὸς ἄμβροτος, οὐκέτι θνητὸς πωλεῦμαι μετὰ πᾶσι τετιμένος, ὥσπερ ἔοικα, ταινίαις τε περίστεπτος στέφεσίν τε θαλείοις: τοῖσιν ἅμ' <εὖτ'> ἂν ἵκωμαι ἐς ἄστεα τηλεθάοντα, ἀνδράσιν ἠδὲ γυναιξί, σεβίζομαι: οἱ δ' ἅμ' ἕπονται μυρίοι, ἐξερέοντες ὅπῃ πρὸς κέρδος ἀταρπός: οἱ μὲν μαντοσυνέων κεχρημένοι, οἱ δ' ἐπὶ νούσων παντοίων ἐπύθοντο κλύειν εὐηκέα βάξιν.
44. Empedocles, *Fragment* 132 (Translation John Burnett, *Early Greek Philosophy*, 3rd edn, A & C Black, London, 1920; section 105, cf. https://en.wikisource.org/wiki/Fragments_of_Empedocles.)
45. Empedocles, *Fragment* 23 from Simplicius *In Phys.* 159.27; Greek text in: *Empedocles, the extant Fragments*, Yale University Press, New Haven, 1981, pp. 101–102 (English translation: Burnett, see previous note.)
46. Empedocles, *Fragment* 17.
47. Empedocles, *Fragment* 35–36.
48. Empedocles, *Fragments* 57, 60, 61.
49. Empedocles, *Fragment* 58.
50. Empedocles, *Fragment* 59.
51. Aristotle, *Physics*, LCL 228:170-171.
52. The Museum of Palaeontology at the University of California points out that there are major differences between Empedocles and Darwinism. "There are, however, major differences between Empedocles's ideas and natural selection in the modern sense: Empedocles conceived of his 'natural selection' as a past event, not as an ongoing process. Once again, we do not know whether Empedocles had actually found supporting evidence for his theories." See ucmp.berkeley.edu/history/ancient.html, retrieved 24 November 2017.
53. 'Divinely guided' is used in the Greek polytheistic sense,
54. Several building blocks of the pagan Greeks have been likewise applied by medieval and Renaissance Christian scholars, but it would be a logical fallacy to conclude these scientists were guilty of pagan thinking for that reason.
55. Evolutionary theory shares elements of post-Socratic secularist and naturalist philosophies, like those of Epicurus and Marcus Aurelius, but this does not make these authors precursors of Darwinism.

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Perspectives on ancient chronology and the Old Testament—part 2

Murray R. Adamthwaite

It is well known that dates for the first millennium BC are fairly firm, and that the Assyrian Eponym Canon has a full record of years as far back as 912/911 BC. However, prior to that the chronology is very much 'up for grabs'. For Egypt, the resort has traditionally been to the so-called 'Sothic cycle' and fixing dates by the few astronomical references in Egyptian records. However, the neat scheme established by this method has in recent years started to come unstuck, and serious challenges have been made against Sothic chronology. In particular, the excavations by Manfred Bietak in the Fakus region of the Nile Delta have revealed what looks very much like the Israelite settlement, but much too early for traditional chronology, i.e. the 12th and 13th Dynasties. From the Mesopotamian and Syrian ends serious discrepancies have also arisen in regard to the later second millennium, especially from the texts from Emar in the Middle Euphrates region. In total, the discrepancies could amount to as much as 250 years.

In a previous article I outlined the conventional schemes of ancient chronology for both Egypt and Mesopotamia, to serve as starting points for discussion and revision. Such a revision is certainly needed if a match with biblical chronology is to be achieved, since the verdict from secularists is that there is no such correlation, therefore the Bible's stories of the patriarchs, Israel in Egypt, the Exodus and Conquest, and even David and Solomon, are to be dismissed as merely pious legends, without historical foundation. Yet even the secularists are prepared to concede that the Divided Monarchy, as recorded in the books of Kings, is historical, so we are compelled to ask: "Where then is the transition point between legend and history?" The answer to such a question becomes subjective and arbitrary.

If, however, our starting point is that the biblical narratives are sober history, but that on the conventionally held chronological scheme evidence of the biblical events is indeed lacking, then the only conclusion is that the conventional chronology must be modified, or even changed rather radically. This, then, is the approach in the present article, as there is mounting evidence that the conventional scheme is in error even on its own terms, let alone in relation to the Bible. However, it should be noted at this point that the approach here is not to do a wholesale reconstruction of ancient history vis-à-vis biblical history, whether that of Courville or Rohl.[1] The aim is the more modest one of starting with the conventional schemes, and then showing the difficulties and inconsistencies inherent in those schemes.

Joseph in Egypt

Much has been written about this issue, into which dynasty he might fit, even if the actual pharaoh remains elusive. I do not propose to go into all the various aspects in this overview article, but there is one important clue which points to a historical setting: when Joseph stripped the power of the nomarchs, or rulers of the provinces, and consequently centralised the government in the palace, while reducing the people to serfdom, as recorded in Genesis 47. Precisely such an event took place in the 12th Dynasty, during the reign of Senusret III, as I have already argued elsewhere.[2] An excerpt from what I wrote there is in order:

> "Under his (i.e. Senusret III) rule the nomarchs lost their traditional power in favour of the vizier, who then directed the administration of the entire country. Battenfield argues that this centralization of power is precisely that of Joseph, according to Genesis 47."[3]

The evidence of the famine tablets from Emar illustrates further the resort to debt slavery by families and the populace at large in times of severe famine. In those texts a man would, in time of famine and distress, sell his family into slavery to a temple official (and thereby connected with the king) in order to maintain life (*bulluṭu*: "to keep alive"); or to take care of those surrendered (*palāḫu*: normally "to fear, revere", but in this context "to treat with respect, take care of"). This is similar to the expression החיתנו in Genesis 47:25, where the Egyptian peasants confess to Joseph, "you have saved our lives".[4]

While memory of Joseph himself may well have been deliberately expunged from the records in a *damnatio memoriae* exercise—fairly typical of what we see at other times in Egyptian history—the sort of development in Genesis 47 is something that we could well expect to turn up in the Egyptian records, and such is indeed the case. Giving this event its due consideration, the Joseph story belongs to

the later 12th Dynasty, possibly the reign of Senusret III or Amenemhet III.

Another point of reference in this discussion concerns the 'Land of Goshen' (Heb. *Eretz Gošen* ארץ גושן; LXX. *gē gesem*; Genesis 45:10; 46:28–29; 47:6). Again, to summarise what I have written elsewhere, as follows:

1. According to Genesis 47:4, 6, the pharaoh allowed Jacob and his extended family to settle in "the land of Goshen", and in verse 11 it becomes clear that this is equivalent to "the land of Rameses". The question then arises: Were either of these names used for the region at the time, especially the latter? Since on any chronology the descent into Egypt preceded the 19th Dynasty Ramesside period the reference has to be retrospective or anachronistic.[5] But how did this name later arise for this region? This question can be answered fairly readily as a result of the work of Manfred Bietak and his team (see further below): the Hyksos capital of Avaris became in the Ramesside period the port for the extensive new capital and royal residence of Pi-Ramesse.[6]

   In other words, the name Rameses in Genesis 47:11 is used anachronistically: the name was attached to it in later years in reference to the extensive building work of Ramesses II, and the biblical author employs this name from his standpoint. However, the site also saw considerable construction activity in earlier centuries, going back to the Middle Kingdom.
2. The modern name of Fakus, a town 7 km south of the modern Qantir, clearly reflects the Ptolemaic name Phacusa for the same region, mentioned in his *Geographica*, where he records that the (twentieth) nome of Arabia had this city as its capital. Egeria, travelling there in the fourth century, likewise observes that the city of Arabia is the land of Goshen.[7] This in turn reflects the Septuagint of Genesis 45:10 and 46:34, where it reads "in the land of Gesem of Arabia" *(en gē Gesem Arabias)*. Qantir is now accepted as the site of Pi-Ramesse, and Phacusa/Fakus is the city which gave its name to the region in its vicinity.
3. Egyptian records mention *Gšmt* for the chief city of the region,[8] which can be identified as *p3-ks* in Egyptian. The prefix *p3* is the definite article, and the *ks* element matches with the phonemes *k* and *s* in the LXX *Gesem*. All in all, the land of Goshen can be identified with the modern Fakus and the surrounding region, and in the immediate vicinity of Avaris and the later Pi-Ramesse, now also confidently identified with the modern Qantir.

Oppression and Exodus

The first point to consider is the Oppression. All too often, commentators assume and speak of '*the* pharaoh of the Oppression', and proceed to identify him with e.g. Seti I (on the late-date model), or Thutmose III (on the conventional early-date model). But does this square with a proper exegesis of Exodus 1? Consider what is recorded: The passage shows a series of initiatives from the palace to control the growth of the Israelite population. The first of these is the construction of the 'store cities' (*'arey miskenōt*) for the pharaoh. Then follow further measures: increased hard labour (vv. 13–14) and enforced infanticide (v. 22). Now each of these measures would require time for both implementation and then assessment. Meanwhile, the population continues to grow. In all, this would envisage a period of at least 50 years to a century, including several pharaohs. The notion of late-date advocates that the cities were built just prior to the Israelites' escape from Egypt pays scant regard to the data of the text, in that they require that the cities were built just prior to the Exodus. To explain: the 13-year reign of Seti I (for the Oppression) plus a few years into the reign of Ramesses II are insufficient for what would be a large-scale project of the construction of store-*cities* (emphasis mine). As Bimson argues:

> "The Biblical traditions, in speaking of a bondage spanning a number of centuries, clearly separate by a considerable period the first task of the people (i.e. construction of the cities) and their eventual escape from Egypt."[9]

Another part of the problem here revolves around how long the Egyptian sojourn lasted. The conventional view, based on the Masoretic text of Exodus 12:40, whereby the period of sojourn in Egypt was 430 years. However, both the Septuagint and the Samaritan Pentateuch, apparently

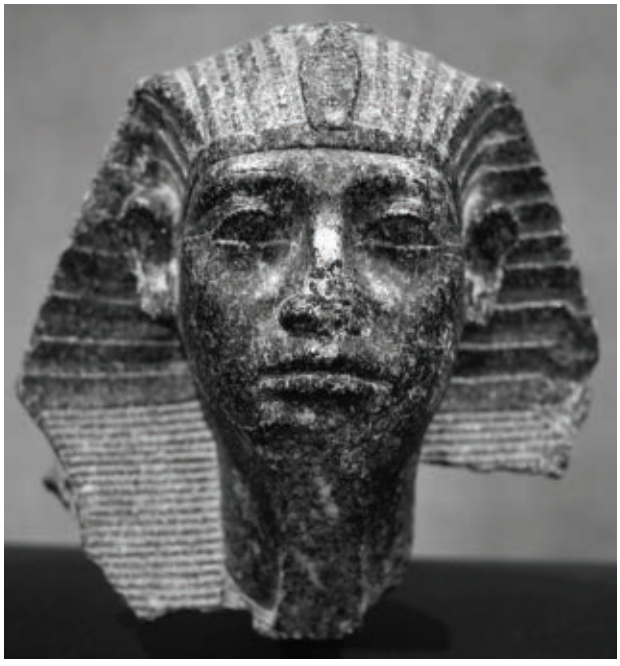

Figure 1. Senusret III of the 12th Dynasty—the pharaoh of Joseph?

following a different textual tradition, read "the sojourning in the land of Egypt *and the land of Canaan* was 430 years" [emphasis added]. This would cut the Egyptian sojourn precisely in half, since an addition of dating notices in the patriarchal narratives gives a total of 215 years. It would also harmonise with Paul's statement in Galatians 3:17 that the Law was given 430 years after Abraham. Regrettably, in the preserved fragments of the Dead Sea scroll 4Q22 paleo-Exodus—in the paleo-Hebrew script—Exodus 12:40 is lacking, thus frustrating any effort to confirm this one way or the other. Nevertheless, speaking generally, since a number of the Dead Sea biblical manuscripts lend support to Septuagint and Samaritan readings their testimony should be taken more seriously than has been traditionally the case. Accordingly, a 215-year Egyptian sojourn should be given serious consideration.[10]

As to Israel's sojourn in Egypt, the above-mentioned work of Manfred Bietak and his team in the Nile Delta (Tell el-Dab'a), has been epoch-making. The following facts emerge from this investigation (using conventional Egyptian chronology):

- It has confirmed that a range of Semitic settlements existed in the region from the 12th Dynasty to the end of the 13th Dynasty and into the early Second Intermediate Period. Although the Semitic population (*aamu*: "Asiatics", to the Egyptians) was sparse from the early Middle Kingdom, from the late 12th Dynasty through the 13th Dynasty there was a population explosion. Yet early in the Second Intermediate Period the settlements suddenly end, and there is a brief occupational hiatus.
- In the period of Hyksos rule the same site became the Hyksos capital of Avaris, until their expulsion after 100 to 150 years of rule.
- Ramesses II expanded this old Hyksos capital, making it his Delta capital of Pi-Ramesse in the 19th Dynasty.[11]
- This region of Tell el-Dab'a was precisely the 'land of Goshen' of the biblical account.[12]

These facts, and others which could be mentioned, really demand that these Semitic settlements are to be identified as Israel in Egypt, even if some of the inhabitants were from elsewhere in the Levant, and from further afield. The latter would accord with the 'mixed multitude' of Exodus 12:38. However, all this is too early for the conventional chronology, and so the scenario has to be otherwise explained. Yet this has proved difficult, even for the secularists, as Dr Janine Bourriau notes in regard to Bietak's pottery finds:

> "When these dates have been imported to sites in Syria-Palestine where objects similar to those from Tell el-Dab'a have been found, there have sometimes been clashes with the existing chronology. The resulting fierce debates, when resolved, will eventually demand radical revisions not only in the dating of strata at Tell el-Dab'a but in the methods used for dating the Middle Bronze Age over the whole Mediterranean region."[13]

Indeed there will be 'radical revisions' (precisely what she does not specify), but one suspects that such procedures will ultimately be in the interests of shoring up the existing scheme. We wait to see which way the proverbial cat will jump. For the present, however, these discrepancies highlight how the existing scheme—with its archaeological evidence—is inconsistent with itself, let alone with the biblical data.

If, as I believe to be the case, Bietak has discovered clear evidence of Israel's sojourn in Egypt, then the Oppression must be identified with the period of the 13th Dynasty, and the pharaoh of the Exodus, following Rohl, be identified as Dudimose, at the close of that dynasty.[14] As Rohl further points out, such an identification accords with Manetho's description of the disaster which befell Egypt at this time:

> "Tutimaeus. In his reign, for what cause I know not, a blast of God smote us; and unexpectedly, from the regions of the East, invaders of obscure race marched in confidence of victory against our land."[15]

Tutimaeus can readily be related phonetically to Dudimose, a later king of the 13th Dynasty, while the tantalising mention of 'a blast of God' can plausibly be referred to the plagues, a devastation which left Egypt open to foreign invaders. In this connection appeal also is sometimes made to the *Admonitions of Ipuwer* as descriptive of the chaotic conditions in the aftermath of the plagues. However, caution is required here: this text belongs to a genre of 'pessimistic' literature from various periods, and betrays no definite historical reference or setting. In fact, the dating of the text is disputed: some date it to the end of the Old Kingdom, others to some time in the Middle Kingdom. In the words of Miriam Lichtheim:

> "In sum, the *Admonitions of Ipuwer* has not only no bearing whatever on the long past First Intermediate Period, it does not derive from any other historical situation."[16]

As stated, one should refrain from appeal to this text in regard to the plagues.

Further to this point on the plague-caused devastation: to explain away their effect as a relatively minor setback, or a more-intense-than-usual series of natural occurrences, from which Egypt quickly recovered, as often alleged by conventional late-date advocates, is to ignore the evidence.[17] This is evident, e.g. from the narrative of the great hailstorm: "So there was hail, and fire flashing continually in the midst of the hail, very severe, such as had not been in the land of Egypt since it became a nation" (Exodus 9:24). Hence if the succession of plagues which Exodus 7–12 relates had the total effect of devastating Egypt's agriculture, its economy, its military capability, and its manpower we can well understand why as a result it was defenceless and wide open to foreign invasion and occupation. Put another way, according to the interpretation proposed here, the succession of plagues brought on the collapse of the Middle Kingdom Egyptian

state, and in turn was one factor which plunged Egypt into the upheavals of the Second Intermediate Period.

Conquest of Canaan

At this juncture, before discussing the Conquest proper, one important matter should be mentioned, which raises a serious problem for the conventional chronology, and in favour of a drastic revision, viz. the discussions by Yurco regarding the Karnak reliefs of Merenptah depicting the same Canaanite campaign recorded in the text of his famous 'Israel stele'.[18] According to Yurco, these reliefs depict a victorious campaign through Palestine by Pharaoh Merenptah (conventionally 1212–1202 BC), with an 'Israel register' (fourth scene) which depicts an Israelite army equipped with chariots having six-spoked wheels—long before (on conventional chronology) chariotry is attested biblically as part of Israel's military technology.[19] Also, the Israelites wear the same city-style dress as do their counterparts in Gezer and Ashkelon. Clearly then, an Israelite army able to engage a pharaoh of Egypt, and field a chariot force in so doing, attests a coherent Israelite nation—not merely an aggregation of tribes, and one which has been resident in the land for a considerable period. Yurco's observations have not only created a serious anomaly in the conventional late-date scheme (remember here that David's conquests were accomplished by infantry, not chariotry), but also point to a much earlier date for Israel's arrival in Canaan—although Yurco himself does not realise the full import of his proposals.

As to archaeological evidence of the Conquest proper, while I will not add to my discussions elsewhere on sites in the Transjordan and the testimony they bear to the Conquest,[20] one point needs to made with emphasis: in Palestine itself there is *no* pattern of heavily fortified, walled cities during the Late Bronze (LB) periods, whether in LB I or LB II. This single observation cancels both the conventional Late Date (19th Dynasty, LB II) or Early Date (18th Dynasty, LB I) schemes of those scholars who adopt the existing secular chronology of Egypt, and attempt to match it to the biblical data. Yet this network of fortified cities was precisely what frightened the Israelites as they contemplated a conquest from the Negev region:

> "Nevertheless, the people who live in the land are strong, and the cities are fortified and very large … We are not able to go up against the people, for they are too strong for us" (Numbers 13:28).
>
> "Our brethren have made our hearts melt, saying, 'The people are bigger and taller than we; and the cities are large and fortified to heaven'" (Deuteronomy 1:28; see also Deuteronomy 9:1).

However, it is in the earlier, Middle Bronze period (conventionally 2000–1550 BC), where we *do* find a system of heavily fortified cities throughout Palestine. The latter part of this period, archaeologically Middle Bronze IIIC, has to be where we place the Conquest. This in turn fits neatly with an Exodus in the same general period (albeit 40 years earlier), as argued above.

One final point in this connection is the oft-repeated scenario of destruction layers in the cities through Late Bronze Palestine, which on the conventional late-date scheme are identified with Joshua's conquest. Even those who adopt the conventional early-date model have (rightly) objected to this identification, citing the biblical data:

- According to Joshua 6:24; 8:28; and 11:11–13, only three cities were burned: Jericho, Ai, and Hazor respectively. The rest were left on their mounds;[21]
- Burning cities was contrary to Conquest policy of living in the homes and cities of the conquered Canaanites, cf. Deuteronomy 6:10–11; 19:1; and Joshua 24:13.

Hence destruction or 'burn' levels in Israelite cities are quite irrelevant and precisely *not* evidence of the Israelite conquest.

The Amarna Letters and early Israel

The Amarna Letters, discovered in 1887 and thus known for well over a century, provide a picture of a Palestine under the control of a range of petty kinglets in a network of city-states, squabbling with each other, and parleying with the Egyptian pharaoh. Thus we see Abdi-hepa ruling in Jerusalem, Milkilim in Gezer, Shuwardata in Gath (?), Lab'ayu in Shechem, etc.[22] Late-date advocates proclaim this as proof positive of a pre-Conquest Palestine,[23] where Canaanite kings are in control of Palestine and Israel not yet in the picture, while conventional early-date proponents have not really come to terms with the evidence of these texts. Some of the latter still cling to the now untenable theory that the Habīru of these letters are the advancing Israelite forces under Joshua, seen from the opposite end of the stick.[24]

However, this neat conclusion is by no means necessary, for the following reasons:

Figure 2. Karnak relief showing Fourth Battle Scene

1. Lab'ayu as king of Shechem poses a particular problem, since according to Joshua 24:1 Israel gathers at Shechem for a covenant re-affirmation, without any interference from local Canaanites. Moreover, Joshua 10–11 relate respectively to a southern campaign and a northern one, but no campaign in the central highlands, the location of Shechem. The impression one gets is that the central highlands—later the tribal territory of Ephraim—were largely empty of Canaanite presence or influence at this time, so for Lab'ayu to be ruling Shechem presents a major problem. However, this person was not king of Shechem, and the only Amarna text which links the two (EA 289) has been misread in the past, and cannot be read so as to link him with Shechem. He is much more plausibly king of Pella (URU*Pí-ḫi-li*) in the Transjordan. Moreover, we cannot even be sure that KUR*Ša-ak-mi* in EA 289:23 refers to Shechem.[25] With Lab'ayu, and an alleged Lab'ayan empire, removed from the central hill country, the scene is open to accommodate early Israel.
2. The list of yet unconquered cities and territories in Judges 1 dovetails with the Amarna Letters as precisely those cities still in Canaanite hands.[26] The only anomalies here are Shechem—which as argued above was not where the Canaanite Lab'ayu ruled his mini-empire—and Lachish, which as a city near the border with Philistine territory could well have changed hands a number of times during the Judges period, even though listed as one which the coalition of kings defeated in Joshua 10:22–27. In 1 Samuel 7:14 there is a circumstantial statement that territory which had been lost to the Philistines was recovered at the time of Samuel: the same might well be said of other localities during the Judges period, given that it was a time of turmoil, with successive oppressions and loss of territory.[27]
3. While various studies have shown fairly conclusively that the term *ḫapīru*/*ḫabīru* (logogram SA.GAZ) is a sociological one, denoting social outcasts and freebooters, reviled by the mainstream populations of cities and villages, and relegated to the fringes of society, a connection with the Hebrews is still possible.[28] While any attempt to relate the term phonetically to 'Hebrew' (*'ibrī*) has now been abandoned, if *ḫabīru* was a general term of opprobrium it could plausibly be applied in this context and circumstance to the Hebrews without any such linguistic relation—although there are indeed problems in that respect also.[29]

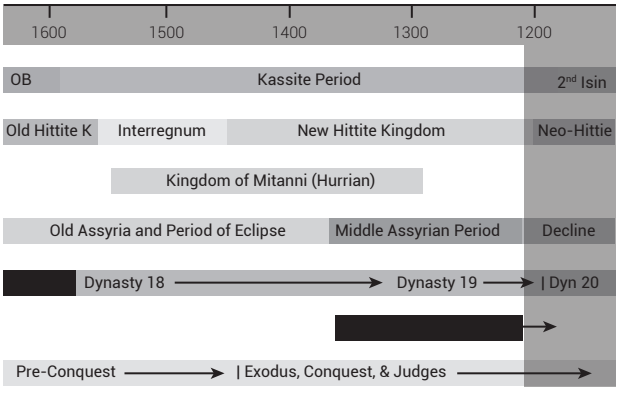

Chart 1. In this chart OB denotes Old Babylonian period; 2nd Isin denotes the 2nd Dynasty of Isin (Babylon).

Early monarchy

When we come to the glory days of David and Solomon, when Israel dominated the entire Levant from the River Euphrates to the river of Egypt (1 Kings 4:21), we could reasonably expect that the evidence in the archaeological record should be abundant. That it is lacking has propelled sceptical scholars to the conclusion that there never was such an empire; at least, not as 2 Samuel and 1 Kings describe it.[30] However, even from a secular standpoint it is difficult, to say the least, to accept that the entire narrative from 2 Samuel 8 through 1 Kings 11 is sheer fiction, as these sceptics would have us believe.

The answer, I am convinced, comes from a re-assessment of the chronology of the period in question: not only to bring it into line with Scripture, but also with itself. Here the texts from Emar on the Middle Euphrates shed some light on the chronological anomalies in the conventional scheme of Mesopotamian and Syrian chronology (CS),[31] and point the way to a new placement of David and Solomon in ancient history. If we start looking in this new time location we shall indeed find a place for and indeed evidence of Solomon's empire.

In order to appreciate the upset which comes from the Emar evidence the following chart displays first the conventional chronology (CS):

For the purposes of this discussion the focus should be on the Hittite, Mitanni, and Middle Assyrian kingdoms. The conventional chronology, as seen in chart 1, shows the latter stages of the Mitanni Kingdom as contemporary

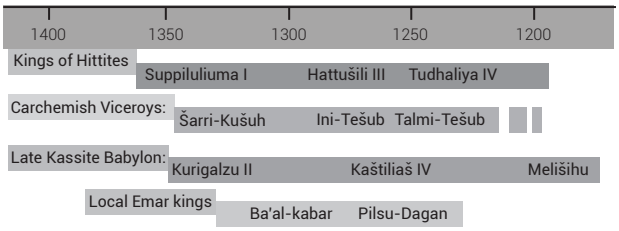

Chart 2. The period covered by the Emar texts showing the various synchronisms, again according to conventional chronology. Names in bold type indicate those kings of Carchemish or Emar with the most attestation, or in the case of Melišihu, significant for the present discussion.

with the rise of Middle Assyria, the last known contact of Assyria with Hanigalbat (i.e. Mitanni) was Šattuara II and Shalmaneser I, when the latter "invaded and destroyed the Hittite-backed kingdom".[32] However, the Emar texts appear to condense these synchronisms into a much shorter timescale, as seen by considering the following anomalies:

Problem 1

Each eponymn at Emar covered two years (as opposed to Assyria's one), and those extant cover a total period of 34 years. Being generous, we could add from scribal careers at most about 45 years, to give a total of 80 years.[33] Hence considerable compression is necessary from the 130 years of conventional chronology as given by Arnaud, the original epigraphist for the texts.[34]

Problem 2

By this scheme Talmi-Tešub of Carchemish does not synchronise with Melišīhu (1188–1174 BC), the last Kassite king of Babylon, but according to the Emar evidence he does.[35]

Problem 3

Emar faced an enemy in its final days, viz. "the king of the Hurri" (i.e. the Hurrians of the Mitanni kingdom). But as seen above, by the time Emar saw its final phase the Hurrian kingdom was well and truly conquered, and had passed into history. The enemy now, according to the conventional scheme, was Assyria, but although several Emar texts mention "a year of distress and war", the enemy is either the Hurri or a mysterious people called the *ṭarwu* (Hurrians?), while the texts are completely silent as to Assyria.[36]

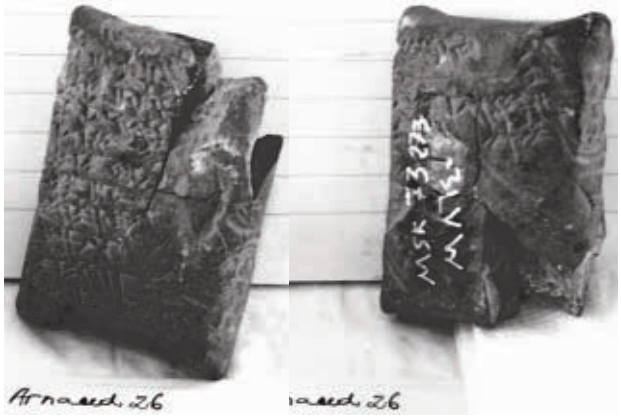

Figure 3. Emar text. Respectively obverse (left) , describing the Hurrian invasion and its repulse, and reverse (right).

Problem 4

Then there is the tablet #26 (figure 3A and 3B), which is dated to the second year of Melišihu of Babylon, the last of the Kassite kings, conventionally dated to 1187 BC. However, this king is around 40–50 years too late for the Emarite kings, going by the attested synchronisms with the viceroys of Carchemish, the latest of whom is Talmi-Tešub. Some scholars, seeing the difficulty, have suggested that this tablet may be intrusive from a later phase, but the archaeology of the corpus will not permit this. The only alternative is to revise the chronology. I repeat here what I have concluded in my published thesis:

> "The whole chronology of the thirteenth century (must) be drastically revised downwards to meet this *terminus ad quem*. This would involve a drastic 'squeezing' of the relative chronologies of the period: Middle Assyrian, Late Kassite, Late Hittite period to fit them into less than a century! Such a shake-up of accepted schemes is hereby proposed as a serious option, and though such a revision should not be based merely on the evidence of one site, nevertheless the Emar texts must be allowed to carry their own testimony."[37]

However, reducing the chronology by 40 to 50 years may not seem a great deal when in regard to Egypt I am pleading for a reduction of around 200 years. However, while the anomaly regarding Melišihu is of the order of 40–50 years, that of Emar *vis-à-vis* the Mitanni kingdom is most likely larger, of the order of perhaps over 100 years. The overall point to grasp here is that of a *minimum amount* in respect of the Emar evidence. The reality could well be much larger. I make two points in this connection:

- The evidence produced above indicates already that anomalies exist in the conventional chronology, of the order of 150 to 200 years in the earlier end of the second millennium (Egypt), and around 60 to 100 or more years at the later end (Syria). These the conventional chronology cannot accommodate, and in turn serve as a pointer or signpost that second millennium chronology needs further revision, and further evidence could well confirm this.
- Even the material produced above regarding Emar has not met with acceptance by mainstream historians, which goes to show that even relatively small-scale revisions (if such they are) face an uphill battle for acceptance.

Summary of the Emar evidence

- The total period covered by the kinglets of Emar must be shortened to about 60 or 70 years, at a stretch 80; but not the 130 years as required by the conventional scheme or Arnaud and others.
- The Emar evidence reveals chronological data which the conventional scheme cannot explain, i.e. in regard to Mitanni and the Hurrians, and is out of harmony with itself.

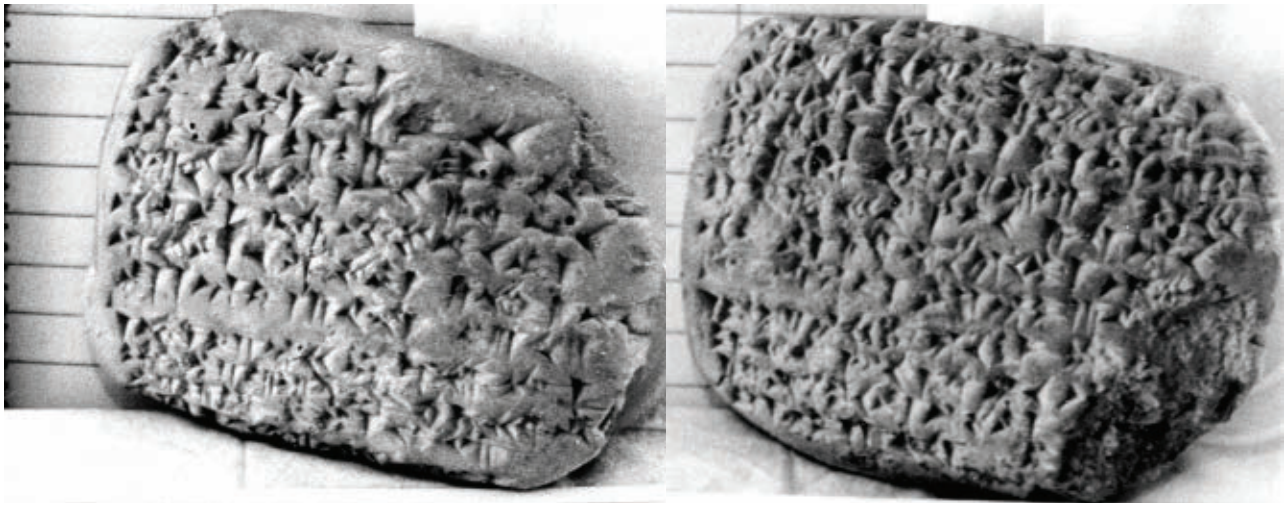

Figure 4. Tablet 42 of the Emar corpus. Respectively obverse (left) and reverse (right)

Implications for biblical chronology

Apart from being out of harmony with itself, the Emar evidence shows also that the conventional scheme of Mesopotamia-Syria in the late second millennium is also out of harmony with the data of Scripture as currently interpreted. Consider here, for example, the picture in 1 Kings 10:29, where Solomon traded with the kings of the Aramaeans and the kings of the Hittites. If we take the Emar evidence and thereby condense the chronology of the Late Hittite period, eliminate the 'Dark Age' in charts 1 and 2 above (which the Emar evidence also strongly suggests, but space forbids me to elaborate[38]), we have a scenario whereby Solomon belongs in the Late Hittite period, where the early Aramaean period also belongs (again, the Emar evidence also indicates this, but space forbids a discussion here[39]). It is in this Late Hittite/Early Aramaean period, archaeologically the Late Bronze II phase, where, I firmly believe, we will find Solomon.[40]

Overall summary

The above discussion has sought simply to highlight anomalies in the conventional chronology at various points, but has not attempted a revised structure. Nevertheless it should be evident that the chronology of the Ancient Near East, in particular the third and second millennia BC, whether in Egypt, Mesopotamia, or Anatolia, is in something of a disarray, and needs serious revision. The work of Bietak in the Nile Delta, the evidence from Emar on the Middle Euphrates, the Karnak reliefs, and reassessment of the Amarna texts all point in this direction, albeit not always to the same extent in each case. Such a revision, therefore, would bring the biblical events out from the realm of fiction into the world of sober reality. Further issues arising from this data will be explored in subsequent articles.

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2. See Adamthwaite, M., Archaeological light on the Old Testament; in: Baker, D. (Ed.), *The Face of Old Testament Studies* (*FOTS*), Baker, Grand Rapids, MI, pp. 75–78, 1999.
3. Adamthwaite, ref. 2, p. 77. The Battenfield reference is to his article, A consideration of the identity of the pharaoh of Genesis 47, *J. Evangelical Theological Society* **15**:77–85, 1972.
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6. Bietak, M., *Avaris: The capital of the Hyksos*, British Museum, London, p. 82, 1995.
7. Wilkinson, J., (Ed. and transl.), *Egeria's Travels to the Holy Land*, Aris & Phillips, Warminster, pp. 100–101, 1981. This 20th nome, called Arabia in Hellenistic times and later, was known as Sopdu in pharaonic times. See Baines, J. and Malek, J., *Atlas of Ancient Egypt*, Equinox, Oxford, pp. 175–176, 1984.
8. Some Egyptologists have read the signs as *Šśmt*, but Naville (Naville, E., The Geography of the Exodus, *J. Egyptian Archaeology* **10**:28–32, 1924) has persuasively argued against this reading. See Adamthwaite, ref. 2, p. 73.
9. Bimson, ref. 5, p. 39.
10. See also Viccary, M., Biblical chronology: our times are in His hands, *J. Creation* **21**(1): 62–66, 2007; Austin, D., Chronology of the 430 years of Exodus 12:40, *J. Creation* **21**(1):67–68, 2007. Viccary takes the view that the Masoretic text as it stands can be taken to mean an Egyptian sojourn of 215 years, without an appeal to the LXX, p. 64. One further point here is that Jewish rabbis apparently held to a 215-year Egyptian sojourn, but that would be the subject of a separate article.
11. A further difficulty for the conventional early-date model (as above) is that the clear archaeological evidence indicates that Pi-Ramesse/Qantir was unoccupied during the 18th Dynasty. See Bietak, ref. 6, p. 273; Baines and Malek, ref. 7, p. 176; Shea, W.H., Exodus, date of, *The International Standard Bible Encyclopedia* **2**:231, 1982, reporting the work of Bietak at Tell el-Dab'a.
12. Bietak, ref. 6, chs ii–vii. See also Bourriau, J., The Second Intermediate Period; in: Shaw, I. (Ed.), *The Oxford History of Ancient Egypt,* Oxford, pp. 186–195, 2000.

13. Bourriau, ref. 12, p. 190. See also Bietak, M. and Höflmayer, F., *Introduction: High and low chronology*, Verlag der Österreichischen Akademie der Wissenschaften, Austria, pp. 13–23, 2007.
14. Rohl, ref. 1, pp. 281–284. Or perhaps another pharaoh of the late 13th Dynasty. Whatever, the 13th Dynasty remains a mystery to a considerable extent.
15. Waddell, W.G. (transl.), *Manetho*, Loeb Classical Library, Harvard University, Cambridge, MA, p. 79, 1940.
16. Lichtheim, M., *Ancient Egyptian Literature*, vol. I, University of California, Berkeley, p. 150, 1975.
17. See the discussion of this 'natural phenomena' view in Currid, J.D., *Ancient Egypt and the Old Testament*, Baker, Grand Rapids, MI, pp. 104–107, 1997. Currid then continues to discuss the more recent position of critical scholars that the plague narratives are merely 'literary creations', pp. 107–108. Kitchen, K.A., A Ramesside Exodus adherent, in his *Pharaoh Triumphant*, Aris & Phillips, Warminster, p. 71, 1982, declares: "The plagues and losses of the (Exodus) year quickly became just an unpleasant memory to be pushed out of mind, and any lesson they taught was soon lost."
18. Yurco, F.J., Merenptah's Canaanite Campaign, *The Journal of the American Research Center in Egypt (JARCE)* **23**:189–215, 1986. See also idem, Yurco, F.J., 3,200-year-old picture of Israelites found in Egypt, *Biblical Archaeology Review (BAR)* **16**(5):20–38, 1990; p. 34; then the challenge by Rainey, A.F., with a reply by Yurco, *BAR* **17**(6):56–61, 1991.
19. Note how both Rainey and Yurco (respectively) note, and try to explain, the problem this poses for the conventional chronology, Rainey and Yurco, pp. 59, 61. The first attested mention of chariots as part of Israel's military force we find in 1 Kings 1:5 and 4:26.
20. Cf. discussions in Adamthwaite, ref. 2, pp. 82–84.
21. For example see Aling, C.F., *Egypt and Bible History*, Baker, Grand Rapids, MI, p. 89, 1981.
22. See Aharoni, Y., *The Land of the Bible*, rev. edn, Burns and Oates, London, pp. 169–176, 1979.
23. While for Aharoni the Conquest begins only *after* the Amarna period, he sees the Habiru/'Apiru penetration during the Amarna period as an earlier arrival of certain Hebrew tribes in a 'split-Exodus' scenario, Aharoni, ref. 22, p. 191.
24. See Wood, L., *A Survey of Israel's History*, rev. edn by O'Brien, D., Zondervan, Grand Rapids, MI, pp. 82–84, 1986; Archer, G.L., *A Survey of Old Testament Introduction*, Moody, Chicago MI, pp. 265–271, 1974. Note also in this respect the discussion by Kline, M., The Habiru: kin or foe of Israel? *Westminster Theological J.* (*WThJ)* **XX**:60–68,1957.
25. See Adamthwaite, M., Lab'aya's connection with Shechem Reassessed, *Abr-Nahrain* **30**:1–19; pp. 8–12, 1992. Support for my reading of the relevant lines in EA 289 came from Anson F. Rainey on a visit to Melbourne University in 2002, when he gave a special lecture on the Amarna Letters, and EA 289 in particular. Partial support for my thesis re Lab'ayu has come from a recently recovered cuneiform inscribed cylinder from Beth-Shan; see Horowitz, W., The Amarna age inscribed clay cylinder from Beth-Shean, *Biblical Archaeologist* **60**: 97–102, 1997.
26. A point also observed by Kline, ref. 24, p. 66.
27. This point will be developed more fully in a forthcoming article.
28. The literature on this issue is considerable, but see e.g. Greenberg, M., *The Hab/piru*, American Oriental Series 39, New Haven, American Oriental Society, 1955; Kline, ref. 24, but also the earlier installments in *WThJ* **XIX**:1–24, 1956; 170–184; then of more recent vintage, Rowton, M.B., Dimorphic structure and the problem of the *'apirū-'ibrīm*', *J. Near Eastern Studies (JNES)* **35**:13–20, 1976; Na'aman, N., Habiru and Hebrews: the transfer of a social term to the literary sphere, *JNES* **45**:271–288, 1986.
29. See the discussion by Kline, ref. 24, pp. 61–63, for an outline of the problems involved in any sort of Habīru/Hebrew identification. My own view is that these problems are not insuperable, but nevertheless full account needs to be taken of the relevant difficulties.
30. See Knoppers, G.N., The historical study of the monarchy: developments and detours, in Baker and Arnold, ref. 2, p. 215, and note 34.
31. As for example, in Bryce, T., *Ancient Syria; A three thousand year history*, Oxford University Press, New York, pp. 332–334, 2014.
32. See Wilhelm, G., *The Hurrians*, Warminster, Aris & Phillips, p. 40, 1989, albeit with some skepticism regarding Shalmaneser's claims; Bryce, *ref.* 31, p. 83; and also Bryce, T., *The Kingdom of the Hittites*, Oxford University Press, New York, pp. 303–304, 1998, where he notes Wilhelm's scepticism, but still insists that Shalmaneser wiped away what remained of the Mitanni kingdom.
33. See Adamthwaite, M., Ph.D. thesis, *Late Hittite Emar*, Louvain, Peeters, pp. 16–25, 2001.
34. See Arnaud, D., Les textes d'Emar et le chronologie de la fin du Bronze Récent, *Syria* **52**:89, 92, 1975. See also discussion in my thesis, ref. 33, pp. 3–4 and notes 2 & 3.
35. Adamthwaite, ref. 33, p. 72.
36. Adamthwaite, ref. 33, pp. 261–272.
37. Adamthwaite, ref. 33, p. 75. See the entire chapter (part I, ch. 5) for full discussion.
38. This concerns the discovery of the standard neo-Assyrian *hilāni*-palace, quite out of chronological location, in Emar of ostensibly the Late Hittite period, 13th century BC. See Margueron, J., Un <<hilāni>> à Emar; in: Freedman, D.N., Archaeological reports from the Tabqa Dam project, *Annual of the American Schools of Oriental Research* **44**:153–176, 1977. See also discussion in Adamthwaite, ref. 33, pp. 201–203.
39. On this matter see my chapter, Aramaean Movements; in: Adamthwaite, ref. 33, pp. 273–278.
40. As also proposed in James, P., *Centuries of Darkness*, Pimlico, London, 1992.

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Carol Cleland's case of historical science—part 2: apologetic for historical science

John K. Reed and Peter Klevberg

Philosopher of science Carol Cleland argues for the epistemic equality of historical and experimental science by making a positive case for historical science. She builds on the foundation of the Principle of Common Cause, using it to justify an asymmetry of overdetermination of historical evidence, and a method that chooses between multiple hypotheses by evidential 'smoking guns'. Although an improvement over crass positivist cases of the past century, her case falls short of its goal. A more robust view of science and history must begin with the rejection of positivism and uniformitarianism.

Secular intellectuals began arguing against biblical history in the 18th century, using deceptive or flawed premises.[1] For example, Lyell linked his uniformitarianism to Newton's uniformity, implying an unwarranted epistemic equality. The most effective Christian response to Lyell did not appear until the mid-20th century, with an emphasis on 'scientific creationism'.[2] Progress back to a Christian worldview has been slow. There is much to do, as naturalism permeates modernity, with multiple layers of distortion affecting even definitions, like 'science'.

Secular thinkers now face the revival of metaphysics in modern philosophy,[3] and 'friendly fire' from postmodernism, in their struggle to maintain a modernist view of science. New secular justifications for natural history are being made by philosophers of science—rather than geologists, paleontologists, and evolutionists. A leader in the field is Dr Carol Cleland. She advances both negative[4] and positive cases for the epistemic equality of historical science and experimental science (figures 1 and 4). After tarnishing the methodology of experimental science, she seeks to build a positive and solid foundation for historical science.

Cleland's positive case: rebuilding historical science

Having argued that the epistemic value of experimental science is less than that perceived by scientists and laymen,[4] Cleland attempts to explain why the value of historical science is greater. Building off *common cause explanation* (connecting disparate forensic effects to a single cause), she notes an *asymmetry of overdetermination* of past causes because the unidirectional causality from past to present implies excess evidence when looking from present to past. From this bounty, multiple hypotheses are resolved by *smoking guns* that provide 'capstone evidence'.

The key to her case is her unique definition of science, *linking hypotheses to evidence*. Though vague, it allows different 'sciences' to have distinct methods while maintaining the same high epistemic status as experimental science, which reduces uncertainty by repetitive, replicable testing. Should 'historical science', which does not employ repetitive replicable testing, enjoy the same level of confidence? Furthermore, are there really multiple 'sciences' in this loose sense? Is forensic natural history a 'science'? These are important questions for both Cleland and for anyone involved in studying natural history.

Basis for historical science: common cause explanation

Rational explanation relies on causality. Cleland builds her case for historical science on a corollary called 'common cause'. *Common cause* links disparate evidential traces to one cause, instead of many unrelated causes. Cleland references Reichenbach[5] as providing a basis for this assumption, although the nature of causality has been heavily discussed since Aristotle.

Common cause explanation in historical science is the *forensic* matching of effects to one cause, such as linking apparently unrelated oceanic trenches, mountain ranges, and compositions of basement rocks to the unifying cause of plate tectonics. But common cause explanation is not a scientific principle:

> "The principle of the common cause is not … a logical consequence of the mathematical theory of probability. It represents a metaphysical conjecture … and this is what makes it a metaphysical thesis, the universe might have been such that coincidences are the rule rather than the exception."[5]

If her 'coincidences' have been the rule rather than the exception, what metaphysical options might make Cleland's conjecture true? She doesn't say. However, she recognizes the dilemma presented by chance:

> "Attributing puzzling similarities and correlations among traces to a common cause has great explanatory power because it makes their joint occurrence credible. Attributing their concurrency to chance, on the other

hand, explains nothing; we are left with an intractable mystery."[6]

Cleland's avoidance of randomness cannot be grounded in materialism, which rests on randomness. Only a rational metaphysical grounding for such a conjecture (i.e. God) can ultimately avoid such complete randomness. But the God who alone can ground Cleland's conjecture is also a God who acts in history and recounts those acts in revelation. Why then does she limit her pool of explanations in natural history to materialistic ones, even in cases where materialistic explanations fail?

> "The best explanation for these remarkable similarities in molecular composition is not that they represent a fantastic coincidence but that all life on earth today inherited them from a last universal common ancestor."[7]

There is a better 'common cause' explanation Cleland doesn't mention: common design and common providence from one God. It explains "these remarkable similarities in molecular composition" as well as common ancestry, and explains other crucial facets of life that common ancestry cannot.[8–10]

Another problem is matching effects of the rock and fossil records with unobserved causes, a problem exacerbated by the paucity of these records relative to the old-earth view of history.[11–15] Cleland gets around these problems in an interesting way, using the linear nature of time to explain how causes and effects are more easily linked looking back in time, rather than forward:

> "The majority of localized cause-and-effect relations form many pronged forks opening in the direction from past to future; the principle of the common cause asserts that most events affect their environments in numerous and diverse ways, producing multiple lines of potential evidence (in the form of correlations and similarities) that persist into the future."[16]

Looking forward, we cannot see the multitude of effects generated by specific causes. But looking back, we see the branching lines of effects from past causes. She argues that even a small sample of the effects is enough to discern a common cause and allow historical scientists to justify hypotheses.[5]

However, a retrospective of Earth science shows that 'unwarranted speculation' forms the bulk of geological literature. Even Cleland seems to realize that her optimism is not always warranted, noting that common cause does not always apply to forensic data.[5] Since no one was present to observe those causal chains, how does one link historical traces to their causes? Cleland does not explain; instead, she diverts her focus to methods, comparing hers with other philosophers of science, Sober and Tucker.[6]

Note how she deftly inserts the critical importance of 'shared background beliefs':

> "Background beliefs play crucial roles at every stage of historiographic research, and this means that scientists do not begin by deciding between an unspecified common cause hypothesis and an unspecified separate cause hypothesis. On the contrary, they start with tentative conjectures about what might have produced the puzzling traces under investigation."[17]

These background beliefs are even more significant than she suggests. She is thinking of superficial ideas, like whether an evolutionary structure is homologous or analogous. In reality, these beliefs are better characterized as paradigms built on worldview commitments, like whether evolution occurred or whether uniformitarianism limits our options for deciphering the past. 'Background beliefs' is shorthand for differences between Christianity and naturalism, and drive interpretation far more than data. Even if we grant her definition and examine the method, questions remain.

In addition to the unquantified influence of background beliefs, the method is rife with uncertainty. Cleland tries to minimize this problem by an *ad hominem* appeal to the judgment of the scientists.[5] But the 'preference' of scientists hardly seems an objective basis on which to decide a hypothesis or build a science.

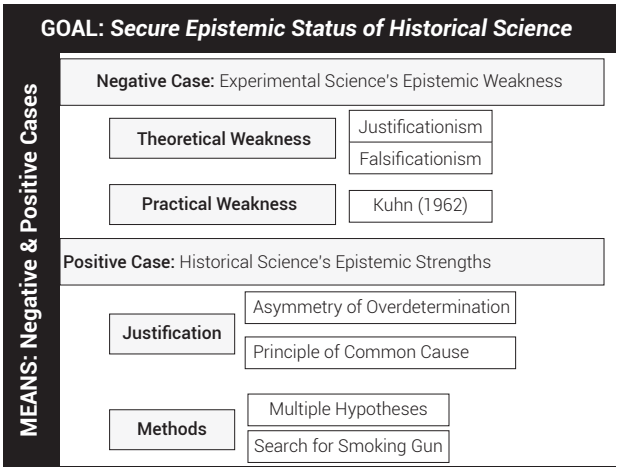

Figure 1. A map of Cleland's argument for epistemic equality of historical and experimental science. She uses both a negative critique of experimental science and a positive case for historical science.

Linking effects to common cause: the asymmetry of overdetermination

If common cause explanation is her forensic cornerstone of historical science, and if uncertainty attaches to discerning such causes, how can she achieve certainty? Experimental science at least reduces uncertainty using techniques unavailable to natural history. The scientific certainty of natural history was simply assumed, thanks to positivism

and uniformitarianism.[18] Cleland is to be congratulated for refocusing on these issues.

Common cause explanation focuses on the directional nature of causality from past to present. Cleland notes two resulting features: (1) causes precede effects in time, and (2) multiple effects flow from a single cause. This creates an expanding panorama of evidence through time. For example, a volcanic eruption produces ash, a peak, and lava flows. Any of these preserved in the rock record tell us that an eruption occurred. To overcome the paucity of the rock record, she proposes that these principles produce *excess* evidence compared to the future. This is called the *asymmetry of overdetermination*, a corollary that evidence for historical causes is excess to forensic need. Effects multiply, impact the environment, and leave a broad trail in the historical record.[16]

In an interesting twist, she uses this asymmetry to favourably contrast historical science to experimental science:

> "Put provocatively, the present does not contain traces (records) of future events as it does of past events. Viewed from this perspective the historical sciences have an advantage over classical empirical science."[16]

At any rate, this principle justifies her basis for historical science in using common cause explanation.[6]

Methods of historical science

If historical science rests on the principle of common cause, and we expect excess evidence, then what are its methods? Cleland presents a forensic method based on the principle of multiple working hypotheses and the means for discriminating the best hypothesis from those options.

Method 1: Multiple hypotheses

Cleland next advocates a two-step method: (1) develop multiple hypotheses, and (2) choose the best one using 'capstone' pieces of evidence. The first is not new; it was advocated by Chamberlain.[19] Unfortunately, it now receives mostly lip service. Multiple hypotheses are allowed as long as they remain firmly within the rigid limits of geological orthodoxy. Alternatives to absolute dates, uniformitarianism, the geological timescale, or plate tectonics are seldom allowed. Multiple hypotheses help, but may not be enough. She notes:

> "The predictions of historical scientists are too vague to specify precise conditions for testing and evaluating hypotheses. They function more as educated guesses … about where additional evidence (ideally a smoking gun) *might* be found and perhaps even what form it *might* take."[20]

This is not a strong case for epistemic equality with experimental science. Experimental testing usually provides greater confidence and less subjectivity than 'educated guesses'. Can the second part of her method—the smoking gun—remedy that weakness, especially in light of the fundamental precept of empiricism that the 'right' answer may be the one yet to be discovered?

Method 2: The search for the 'smoking gun'

A staple of television mysteries is a long, fruitless trek through red herrings, followed by a short climax, where a brilliant detective finds the one piece of evidence that solves everything. This is Cleland's view of historical science:

> "… scientists investigating long past events and processes exhibit a distinctive pattern of evidential reasoning characterized by two interrelated stages: (1) the proliferation of rival hypotheses to explain a puzzling body of traces … discovered in the field, and (2) a search for a 'smoking gun' to discriminate among these hypotheses … by showing that one or more provides a better *explanation* for the total body of evidence (traces) available than the others."[21]

How are geologists to discern smoking guns from less important data? She believes that the context of competing hypotheses defines such evidence:

> "Rival hypotheses are formulated on the basis of a body of traces that doesn't include a smoking gun. The discovery of a smoking gun changes the evidential situation by revealing that one or more of these hypotheses provide a better explanation for the total body of evidence now available. Considered in isolation, independently of the other lines of evidence, few traces would unambiguously count as a smoking gun for a hypothesis. A smoking gun for a hypothesis is a capstone piece of evidence; it can only be judged as a smoking gun when combined with the rest of the evidence available."[21]

Is this circular? Cleland deflects that question with a pragmatic justification:

> "The point is regardless of the circumstance in which it is acquired, whether a result of 'prediction' or serendipity, evidence functions as a smoking gun if it establishes that one hypothesis provides a better explanation than its rivals."[20]

Discussion

Cleland bases historical science on her idea that 'science' is nothing more than linking hypotheses to evidence. The investigation of historical traces rests on *common cause* and the *asymmetry of overdetermination*. Uncertainty is reduced by multiple working hypotheses, and the use of *smoking guns*. As a result, Cleland's historical science, despite different methods and objects of inquiry, performs

the same fundamental task as experimental science (figure 2). Doing so makes them epistemic equals.

There are positive aspects of Cleland's work. She recognizes the positivist arrogance of modern science. She has also attempted a unifying vision that would justify modern confidence in geohistory and biohistory. The logical links between her definition of 'science', her foundation of common cause, evidential implications of the asymmetry of overdetermination, and her method is a noteworthy accomplishment, far superior to simplistic views of men like Lyell. However, Christians should approach her work cautiously.

Critique 1: No escaping positivism

Many of Cleland's problems stem from her ambivalence about positivism. On one hand, she rejects an outmoded scientism, but she wants the same certainty for natural history.[22,23] The idea that forensic history is not science cannot be contemplated. This shows in her uncritical acceptance of evolution and theories like an end-Cretaceous extinction impact. Though disappointing, her inability to step outside her worldview is understandable. Christians must also beware this trap. Many fall into serious error seeking to accommodate naturalism. On one end are those who think science invalidates the factual content of the Bible; on the other are those unconsciously imbibing the assumptions of naturalism. Even creationists have displayed an echo of positivism in the 'origin/operation' science model.[22]

Critique 2: Conflating 'science' with 'empirical'

When science became the arbiter of truth, there was a stampede to label all disciplines 'sciences' so that they could enjoy the same status. Drawing disciplinary boundaries in the traditional way—by methods, questions, and objects of inquiry—became confused. It is a category error to make 'science' and 'empirical' identical in meaning and scope. Cleland does not escape it, as is evident in her definition of science. Correcting this problem requires recognizing that there are empirical disciplines that are not 'science', like history and philosophy. Adler[24] describes a better method for classifying disciplines (figures 3 and 5).

Critique 3: Reducing history to common cause

Aristotle entertained a much wider understanding of cause than many of today's scientists. His material, formal, efficient, and final causes have been restricted in modern science to the material and efficient. That worked well as long as people understood that *purpose* was still there, but described by theology and philosophy. Cleland's basing historical science on common cause explanation is certainly a *part* of forensic natural history. But it is not the totality:

> "One limitation of Cleland's characterization of prototypical historical science is that there is quite a lot of broadly historical natural science that does not fit her description very well."[25]

Turner specifically mentions looking for statistical patterns in large data sets and the role of modelling in natural history. Thus, Cleland's reliance on common cause explanation is reductionist, both in its understanding of natural history and causality.

Critique 4: Common cause vs random materialism

Cleland assumes a rationality in both nature and history at odds with the random reality of modern materialism.[26,27] It persists because Enlightenment rationalists unconsciously maintain a Christian worldview by assuming a rationally ordered cosmos. But postmodern nihilism has forced naturalism towards irrationality. Only the Christian worldview offers a rational justification for science. Cleland affirms evolution and the routine secular narratives of natural history, and in part recognizes her problem:

> "Attributing puzzling similarities and correlations among traces to a common cause has great explanatory power because it makes their joint occurrence credible. Attributing their concurrency to chance, on the other hand, explains nothing; we are left with an intractable mystery."[16]

But 'chance' is only unlikely and undesirable if the cosmos is uniformly ordered such that improbable associations typically do have common causes, and the only rational explanation of universal, uniform order is the Christian God who grounded the rise of science and natural history in the first place. Yet even with her insistence on multiple hypotheses, she never explores that

	Experimental Science	Historical Science
Objects of Inquiry	Hypotheses address regularities or types	Hypotheses address specific events in past
Method	Hypotheses tested in controlled lab	Smoking gun chooses best hypothesis
Justification	Inductive or falsificationist	Principle of common cause rests on overdetermination

Figure 2. Cleland contrasts experimental science and historical science based on their distinct foundations and derivative methods.

reasonable and compelling explanation as a potential solution to her 'intractable mystery'.

Critique 5: Assumption of linear time

The asymmetry of overdetermination of historical evidence rests on the metaphysical assumption of linear time. Cleland does not justify this assumption, much less note it. She is not alone; almost all adherents of secular natural history assume it without question.[28] That view of time is justified by biblical theology alone.[29] It remains an irony of modern science that it was the foundation (in uniformitarianism) of those fighting the Bible. Hutton was one of the few to posit a different view of time, but his squishy eternalism was quickly squelched by Playfair and Lyell.[30] Gould's interesting discussion of the interplay between linear and cyclical history shows that linear time is not self-evidently true.[31] Cyclical views have existed before and persist today. Linear time came from the Bible, as did uniformity and the progressive unrolling of history.

Critique 6: Prediction vs retrodiction: a false analogy

When Cleland uses the asymmetry of overdetermination to argue that historical science is superior to experimental science, she sets up the false analogy of comparing evidence of past events to evidence of future events:

> "The asymmetry of overdetermination holds that most localized events epistemically *over*determine their past causes … and underdetermine their future effects … . The overdetermination of the localized past by the localized present explains how geologists can confidently infer the occurrence of individual volcanic eruptions that occurred tens of millions of years ago. The underdetermination of the localized future by the localized present explains why it is so much more difficult for geologists to predict the occurrence of even imminent future eruptions."[32]

When Cleland claims that our knowledge of past events is greater than our knowledge of future events, she fails to note one of the key differences between science and history. Science investigates *timeless general principles* of nature, which help us understand past, present, and future. However, that knowledge does not guarantee knowledge of *specific* future events. The issue between experimental and historical science is not knowledge, but the confidence that comes with that knowledge. This dilemma is better resolved by seeing science and history as distinct disciplines, rather than competitors for the title of 'most scientific'.

A related error is her contrast of past vs future knowledge, rather than past vs *present* knowledge:

> "… the present does not contain traces (records) of future events as it does of past events. Viewed from this perspective the historical sciences have an advantage over classical empirical science."[16]

Science increases our knowledge of our *present* environment. This enables future prediction, but that prediction can only be specific if it is directly related to these general principles. For example, we can predict that volcanic lapilli will fall with the same acceleration of gravity at any time, even if physics cannot predict the eruption ahead of time. And our knowledge of the present is much greater than that of the unobserved past.

Critique 7: Blanks smoke too

Perhaps one of the most innovative features of Cleland's justification for the epistemic equality of 'historical science' with 'experimental science' is her hierarchy of evidence, with 'smoking guns' at the top. But rival hypotheses are seldom weighed objectively.[33] In reality, ruling paradigms and bandwagons drive historical science more than 'smoking guns'. How many 'smoking guns' did it take for geologists to accept the Lake Missoula Flood? Vine and Matthews[34]

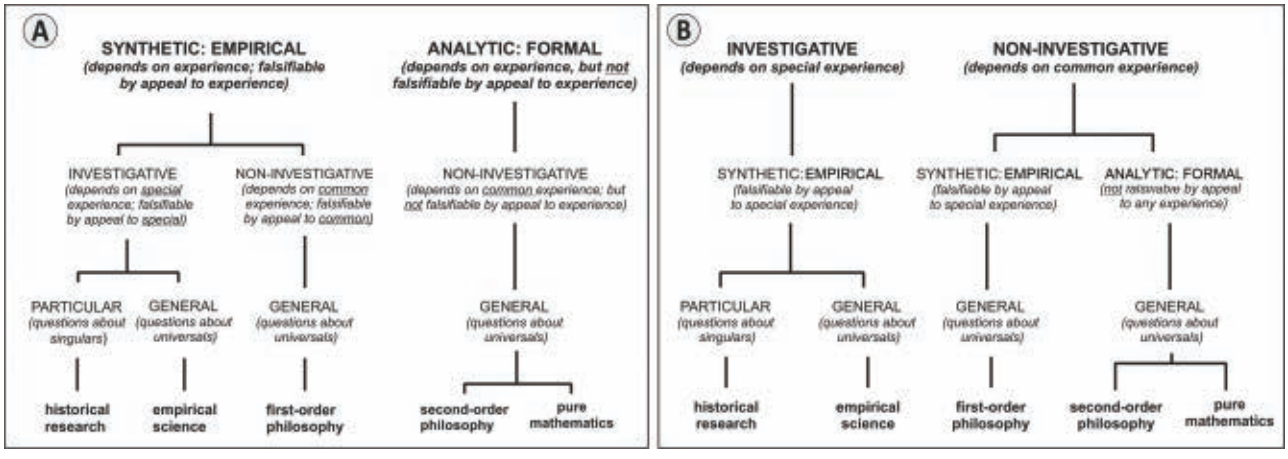

Figure 3. Adler's classification of disciplines based on the dual dichotomies of empirical vs formal and investigative vs non-investigative.[24] Science cannot be defined simply as 'empirical' but is distinguished by its object of inquiry, questions about universal principles of nature.

characterized anomalies near Iceland's mid-Atlantic ridge as 'proof' that sea-floor spreading has occurred in the past, yet further study has shown that their understanding of the evidence was less than clear.[35] Cleland's *purpose* for smoking guns is also questionable. She states that they clarify hypotheses that are "better explanation[s] for the total body of evidence". It is ironic that, having disparaged experimental science for problems of data completeness, objectivity, and unknown variables, the same issues are fixed in historical science by 'smoking guns':

> "Finally, it is important to keep in mind that the findings of historical scientists are just as tentative and subject to revision as those of experimental scientists".[21]

Thus, a 'smoking gun' is the important data (or interpretation) *at the time*, based on the shifting context of the scientists' belief system and experience. This can be avoided by Christians by defending the Bible as a source of absolute truth, recognizing that science and history are different disciplines, and seeing geohistory and biohistory as mixed questions, which require equally valid input from theology, philosophy, science, and history.[23]

Figure 4. Dr Carol Cleland is a philosopher at the University of Colorado, Boulder, specializing in understanding the logic and philosophy of science. Her interest in historical science seems driven by a desire for epistemological equality as defined by method, and results in the assimilation of historical inquiry into a broader scientific method.

Critique 8: Is the rock record complete?

Cleland does not describe how the overdetermination of past evidence can overcome the fundamental paucity of the rock and fossil records relative to her long-age understanding of Earth's history.[36] Her view that there is excess evidence is at odds with geologists, who worry about its incompleteness and the implications of preservation potential for stratigraphy and paleontology. Ager[37] said that there was 'more gap than record' and that the record consisted of a series of 'frozen accidents'. Van Andel warned:

> "… invariably we find that the rock record requires only a small fraction, usually 1 to 10 percent, of the available time, even if we take account of all the possible breaks in the sequence. Evidently deposition, unlike work in Murphy's Law, does not expand to fill the time available. This might in principle be expected but the universality and especially the magnitude of the shortfall are startling."[38]

Similar concerns have been expressed by Sadler,[12,13] Torrens,[14] and Bailey and Smith, who note that "it should always be borne in mind that the record may not be representative of this history".[39] It is not enough that we have evidence of the past and that properties of causality may supply redundant evidence. A high confidence in the translation of a paragraph means little when it is all that remains of a book.

Critique 9: Historical science in practice

Cleland pointed out failings of practice in experimental science. Yet the same problems are true of historical science, where the same mechanisms for reducing subjectivity are not available. Kuhn[40] criticized the control of experimental science by paradigms, yet the role of beliefs in historical science is much greater, as illustrated by evolution—a theory that cannot be falsified, despite abundant negative evidence. Moreover, Rudwick[41] noted that researchers were confident in deep time *a priori*.

Geologists cannot even describe their own history in a reliable manner. Gould[31] called the standard account of the history of geology a 'cardboard empiricist myth'. The heroic sagas of Hutton, Playfair, and Lyell devolve into much more complex stories as new studies delve into the interacting personalities with competing agendas, oversized egos, and a desire for fame and fortune.[41] They were united only by a common animosity to biblical history. That bias remains, and may be the dominant theme of geohistory and biohistory since the 18th century.

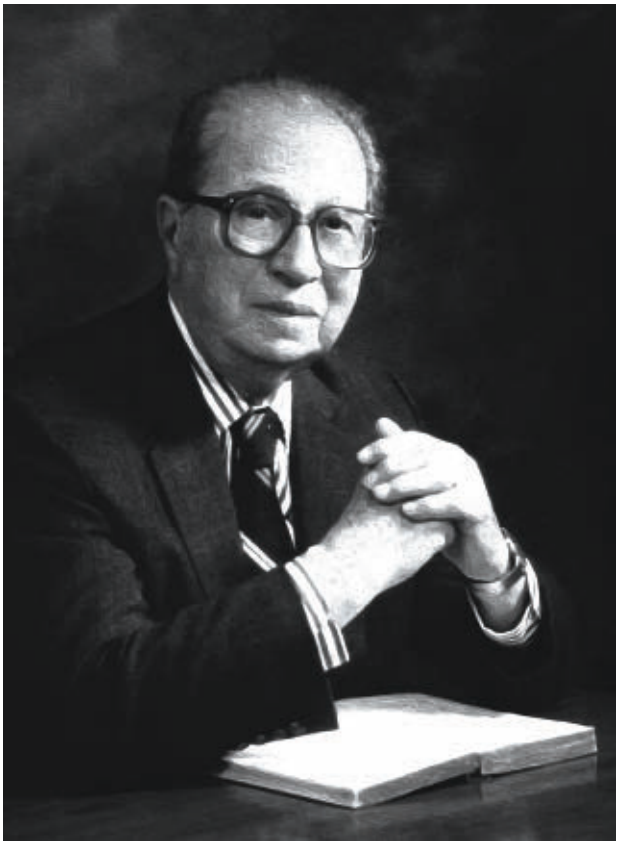

Figure 5. Dr Mortimer J. Adler (1902–2001) was an American philosopher, educator, and writer. He was involved in the *Great Books* program, was an editor of the *Encyclopedia Britannica*, and helped found the Aspen Institute. He pursued truth through philosophy, saw a distinction between the disciplines of science and history, and advocated a cross-disciplinary approach to questions that spanned those boundaries.

Critique 10: Best in field fallacy

Cleland does not account for the best-in-field fallacy.[42] This occurs when problems surface with models, and proponents do not answer the objections, but only respond that their model is better than competing hypotheses. As MacBeth noted, this approach measures truth by an appeal to the power of explanation, not by logic or evidence:

> "It seems that the standards of the evolutionary theorists are relative or comparative rather than absolute. If such a theorist makes a suggestion that is better than other suggestions, or better than nothing, he feels that he has accomplished something even if his suggestion will obviously not hold water. He does not believe he must meet any objective standards of logic, reason, or probability."[43]

In falling into this trap, Cleland stated:

> "The point is most historical hypotheses are not rejected on the basis of failed predictions but rather because another hypothesis does a better job of explaining the total body of evidence available."[20]

While a hypothesis may do 'a better job' of explaining data, that is not the measure of truth.[44] Cleland is caught in a trap of her own devising. If natural history is a subset of history, with the inherent uncertainty of history, then tentative models explaining limited data are acceptable. But if one insists that natural history has scientific certainty, the standard of proof is much higher. Simply having the best story is not enough.

Critique 11: Role of belief systems

Natural history has seen a clash of belief systems. Cleland is on firm ground in her understanding that background beliefs play a role in historical science. Unfortunately, she does not grasp her own biases. Naturalism is not an inherently scientific mindset, as its devolution into postmodern relativism is demonstrating. Christianity, and only Christianity, gave rise to science.[45] It did so with a unique collection of background beliefs that provided a cultural environment that fostered its purposes, strategies, and methods. Lyell and his intellectual children enjoyed the fruits while rejecting the tree. They caught the coat-tails of Newtonian physics, thinking natural history could be equally scientific. Cleland seeks the same goal by a different road. Her 'multiple hypotheses' excludes those of creationists, even when evidence strongly supports their ideas. Few secular geologists are willing to admit that uniformitarianism is not able to explain the rock record, and no secular geologist will face the implications of geology having been built on that false principle. Secular geologists and biologists are ill-equipped to address their worldview and retain large blind spots for that reason. It is understandable that scientists, given the inculcation of naturalism in education at every level, would fall prey to such problems. But philosophers of science are supposed to address those problems.

Conclusion

While Cleland's positive case for historical science is an improvement on Lyell's, her case falls far short of demonstrating an epistemic equality between natural history and experimental science, primarily because she is asking the wrong question. In conflating 'science' with 'empiricism', she requires that history become science. This should be a warning, since this error is at the root of the Christian redefinition of 'origins/operation/historical/supernormal science'.

Cleland makes an interesting case with a consistent foundation and method. However, it depends on suspicious assumptions and does not account for the scope of historical science. Until a better case is made, we cannot agree that

historical science is the epistemic equal of experimental science in the sense of having equal confidence in their conclusions because the experimental method allows a reduction in subjective elements that forensic history does not. Thus, we[23] continue to assert that Adler[24] provided a superior basis for natural history as a mixed question, incorporating truth from science, history, philosophy, and theology.

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The meaning of unconformities

John K. Reed and Michael J. Oard

An important distinction between diluvial and uniformitarian geology is their contrary interpretive approach to unconformities. Uniformitarian geology has long emphasized unconformities as repositories of all the time that cannot reasonably be attributed to the strata. But that interpretive framework would be unworkable if most unconformities formed during the Flood. Diluvial geology must focus on the physical interplay of hydraulics, tectonics, and sedimentology to investigate the formation of erosional surfaces of all scales.

Dramatic events, like Archimedes' bathtub and Newton's apple tree, persist across the landscape of science. For geologists, that moment was the 1788 boating expedition of Hutton, Playfair, and Hall off Siccar Point, Scotland. This was when Playfair saw an angular unconformity, thinking he 'gazed into the abyss of time'. Unconformities of much greater extent and duration, like the Great Unconformity of North America (figure 1), have since been discovered, but Siccar Point remains a Mecca for geology students. Though quite readily explainable in a diluvial framework,[1] its only significance to the uniformitarian faithful is as an icon of uniformitarian deep time:

> "The idea of time as an abyss was borrowed from Buffon, *but it encapsulates what Playfair's generation (and others since) found most striking about Hutton's system* [emphasis added]."[2]

Playfair's interpretation firmly steered the understanding of unconformities away from any mechanical investigation of their formation and towards a role as repositories of deep time. That framework has remained unchanged, despite modern pressures from sequence stratigraphy and neocatastrophism. But biblical history demands that most unconformities formed rapidly.

Unconformities: two approaches

Diluvialists and uniformitarians can agree that unconformities represent erosional or non-depositional processes over time between the emplacement of two adjacent rock units distinct in lithology, geometry, or biota. But how those factors (time and process) are weighted is quite different. Uniformitarian geology uses the 'stratigraphic approach'—focusing primarily on the duration of time represented by an unconformity.[3] The contrary view—the 'dynamic approach'—focuses on the mechanics of deposition and erosion. The stratigraphic approach has become synonymous with uniformitarian geology because that framework for understanding the sedimentary record demands vast amounts of time *not* seen in the actual strata.[4] From Barrell[5] to Ager,[6] geologists have recognized that the actual rocks represent only a small fraction of deep time;[4] thus, unconformities buffer forensic uncertainty by providing the illusion that we can see the missing time.

Stratigraphic approach embedded in definition

The temporal bias of the stratigraphic approach is clear even in the dictionary definition of 'unconformity'. Neuendorf *et al.* define an unconformity as:

> "(a) A substantial break or gap in the geologic record where a rock unit is overlain by another that is not next in stratigraphic succession, such as an interruption in the continuity of a depositional sequence of sedimentary rocks or a break between eroded igneous rocks and younger sedimentary strata. It results from a change that caused deposition to cease for *a considerable span of time*, and it normally implies uplift and erosion with loss of the previously-formed record [emphasis added]."[7]

This 'substantial break' or 'gap' in the passage of time clearly infers deep time, which has been the fundamental assumption of geology since the late 1700s.[2] Geologists 'see' an interruption in the stratigraphic succession in an unconformity, which assumes much time because they assume uniformitarianism and its timescale. This emphasis is obvious in "the considerable span of time" in the second sentence. In a sense, the definition is circular: an unconformity is defined by reference to deep time, and then presented as *evidence* of the lapse of a 'considerable span'. The second definition of 'unconformity' relates it to surrounding strata:

> "(b) The structural relationship between rock strata in contact, characterized by a lack of continuity in deposition, and corresponding to a period of nondeposition, weathering, or esp. erosion (either subaerial or subaqueous) prior to the deposition of the younger beds, and often (but not always) marked by absence of parallelism between the strata; strictly, the relationship where the younger overlying stratum does not 'conform' to the dip and strike of the older underlying rocks, as shown specif. by an angular unconformity."

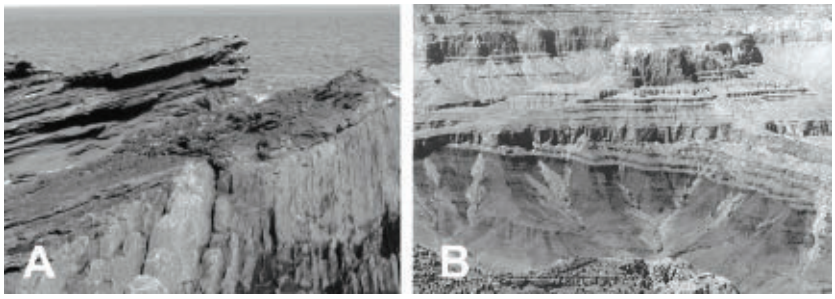

Figure 1. Hutton's unconformity at Siccar Point (A), though much smaller than the Great Unconformity in North America (B), has an unmatched emotive value in promoting deep time.

This definition focuses on tangible causes, but only with causal mechanisms consistent with deep time. A period of nondeposition or erosion brings to mind a stately sea-level change and its erosion. Weathering, uplift, and erosion are thought to be slow processes. Thus, the physical causes for strata failing to maintain consistent strike and dip are put in the context of deep time. The third definition notes specific types of unconformities (figure 2):

> "(c) *surface of unconformity*. Common types of unconformities recognized in U.S.: *nonconformity; angular unconformity; disconformity; paraconformity*. Since the essential feature of an unconformity, as understood in Great Britain, is structural discordance rather than a time gap, the British do not recognize disconformity and paraconformity as unconformities."[7]

Stratigraphic approach built into geology

Miall[8] recounts the work of Blackwelder,[9] Grabau,[10] and Barrell[5] in the early 20th century, who refined the stratigraphic approach, discussing theoretical reasons for the uniformitarian distribution of accommodation space, preservation, and unconformity-bounded sequences. Levorson[11] described the stratigraphy of central North America as natural groupings of strata between unconformities. Wheeler[12] developed a chronostratigraphic depiction of strata that made the stratigraphic approach normative in geological cross-sections. This all anticipated the work of Larry Sloss[13] in defining continent-scale megasequences.[14]

It is worth noting the influence of Wheeler charts, which use *time* as the Y axis, masking the physical geometry of strata and erosion. A wide gap on a Wheeler plot means a *long span* of time, even if physical evidence does not show it. Such a stratigraphic presentation carries a subliminal bias towards deep time:

> "Wheeler (1958) developed the concept of the chronostratigraphic cross-section, in which the vertical dimension in a stratigraphic cross-section is drawn with a time scale instead of a thickness scale. … In this way, *time gaps (unconformities) become readily apparent*, and the nature of time correlation may be accurately indicated. Such diagrams have come to be termed 'Wheeler plots' [emphasis added]."[15]

Wheeler charts replace a primary field property—thickness—with an imaginary 'thickness' of time. In other words, on a Wheeler chart, a 5-m-thick unit may appear identical to a 5,000-m-thick unit, because they are interpreted as occupying the same amount of time. This accustoms people to think they *see* deep time in addition to strata. The COSUNA charts, published by the American Association of Petroleum Geologists,[16] use the Wheeler method, illustrating the visual distortion when compared to a plot using physical geometry (figure 3).

In the latter half of the 20th century, two developments affected our understanding of unconformities. First, sequence stratigraphy[18] opened the door to a dynamic approach, but uniformitarianism was so ingrained that little came of it. But unconformities *per se* were re-emphasized on a variety of scales, up to global eustatic curves. Creationist views were

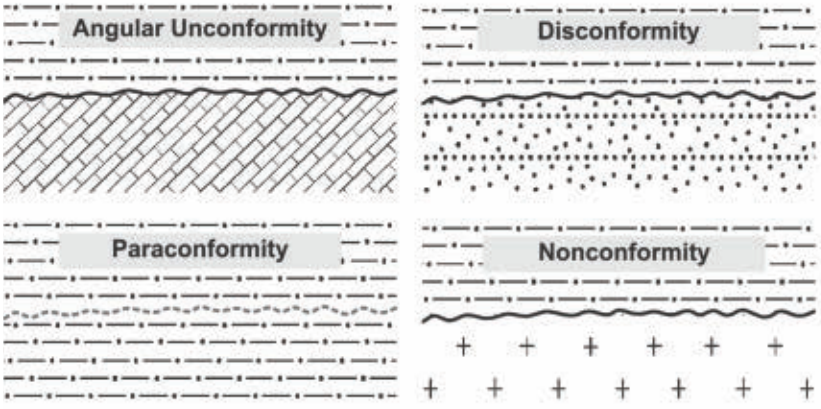

Figure 2. Types of unconformities: (A) *Angular unconformities* are erosional surfaces between strata which exhibit different strikes and dips above and below the unconformity; (B) *disconformities* are erosional surfaces between distinct yet parallel sedimentary strata; (C) *paraconformities* represent the assumed absence of time, but without any physically significant surface or angle between the strata; (D) nonconformities are surfaces separating sedimentary layers above from igneous or metamorphic rocks below.

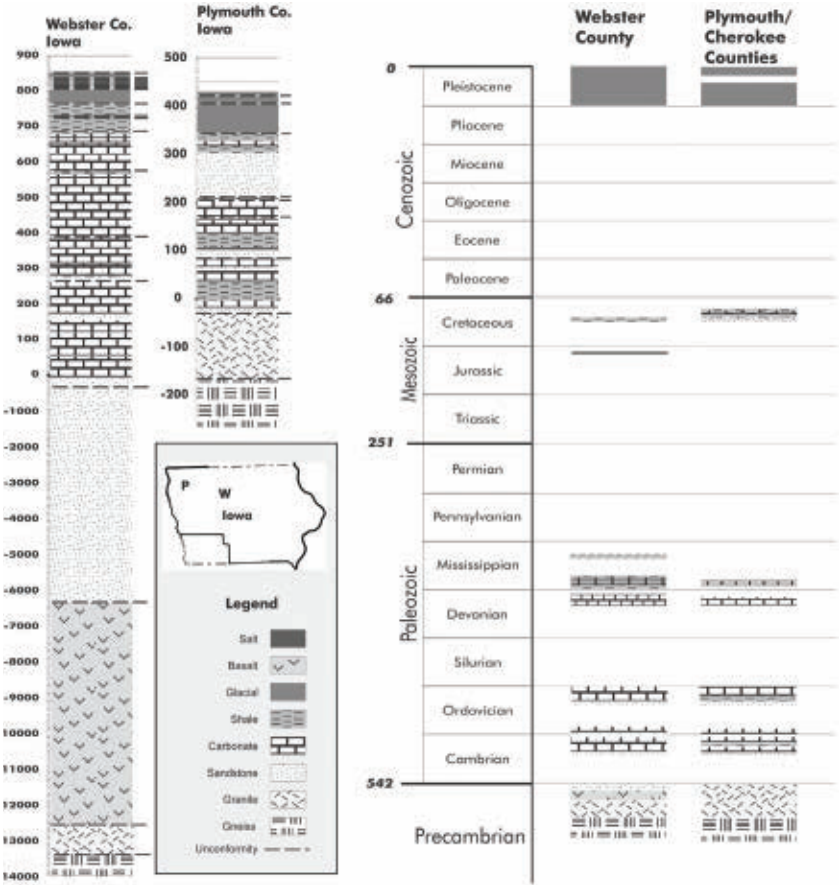

Figure 3. Two stratigraphic sections in Iowa, based on COSUNA charts. Contrast the visual impact of the presentation by thickness and lithology (left) and the stratigraphic interpretation (right). Note the vast amount of time pigeonholed into major unconformities. Note the 10x vertical scale change in the left Webster County column.[17] Thicknesses are averages of ranges provided by COSUNA charts, and thus are approximations for any given location.

published in the 1990s,[19] though research today is focused on large-scale sequences.[20] Second, the rise of neocatastrophism forced geologists to confront the amount of time actually residing in unconformities. Ager[6] was famous for his comments that the record was comprised mostly of gaps. Saddler[21] noted that accumulation rates diminish with time. Bailey and Smith[22] noted the ubiquity of unconformities at all scales, and the corollary that most stratigraphic charts vastly overstate the actual time in the rocks. Miall responded with a defense of uniformitarianism,[23] and proposed that the wide variation in the scale of sedimentary events provides a representative record.

Dynamic approach of Flood geology

Uniformitarian geology favours the stratigraphic approach, but diluvial geology is restricted to one approach—the dynamic. How do these fundamentally distinct approaches to unconformities affect stratigraphic and historical interpretation?

Quantity of time minimal. Uniformitarians grant that a single waveform can form in a matter of seconds, but assert that increasing physical scale demands an increasing temporal scale—up to 10^7–10^8 years for continental scale sequence boundaries.[23] We reject that link between temporal and physical scale; the Flood was an event of great energy, in both extent and intensity. Even large sequence boundaries may have formed in hours; the major constraint being the upper boundaries of the motion of large volumes of water.

Unconformities reflect changes in flow. If most of the rock record was produced in a year, then unconformities mark rapid tectonic and hydrodynamic changes. Changes in current direction, velocity, and depth can produce rapid changes in erosion and sedimentation, as seen on a small scale in modern floods. Extrapolation to larger scales is consistent with both actualism and the Flood.

Global signatures. Large unconformities are not necessarily time boundaries correlated to a global timescale, but are more likely signatures of hydraulic and tectonic events that cannot be synchronized to any fine scale during the Flood. Thus, the criteria for correlating unconformities must be reassessed. Modern correlation methods—fossils, astronomical cycles, etc.—are largely irrelevant to diluvialism.

Unconformities keyed to events. Inundation was rapid, but was complete within 150 days. During that time, interactions between flowing water and topography produced distinct local to regional signatures, sometimes in minutes to hours. The hydraulic environment is therefore more significant than time.

Completeness of record. If the Flood was a global one-year event, and if unconformities represent hydrodynamic and tectonic shifts of hours to days, then the Flood record (including unconformities) is much more complete in the domain of time than the uniformitarian stratigraphic record. Thus, quantifiable sedimentological analysis would also carry more historical certainty.

Fossil record result of transport, burial, and preservation. In marked contrast to uniformitarian stratigraphy, fossils rarely represent *in situ* snapshots of ancient environments.

Thus, while there is likely a recognizable pattern to fossil burial during the Flood in any given location, using biostratigraphy to control the timing of unconformities is based on faulty assumptions.

Exciting research opportunity. Uniformitarian geologists have been blinded to rapid, large-scale sedimentation by their obsession with the time-stratigraphic importance of unconformities. This is an opportunity for diluvial research today, which a few have begun to seize.[24–30] Research into hydrodynamic causes of large currents and waves also has the inherent advantage of a closer link to the physics of fluid flow and sedimentation.

Discussion

The stratigraphic approach interprets unconformities primarily by the duration of time represented by the absence of and/or erosional truncation of strata. While stratigraphers also address the geographic scale and environmental setting, uniformitarianism and deep time still control interpretation. Otherwise, it would not have taken decades for the overwhelming sedimentological and geomorphic evidence to convince geologists of the historicity of the Lake Missoula Flood.[31,32] A dynamic approach would make hydrodynamic and tectonic setting the primary focus, considering water moving at scales not seen today as the most likely cause of unconformities.

Uniformitarian geology uses stratigraphic analysis to posit nebulous low-energy processes acting over long periods of time. Sedimentological analysis offers a more robust look in its ability to quantify current velocity, depth, and channel size. For example, the transport of boulders demands large, fast currents. Oard[33] used erosional remnants, coal rank, and the volume of coastal plain sediments to estimate the volume of erosion in the Appalachians.

Unconformities and stratigraphic completeness

Unconformities as erosional surfaces do not directly yield information about the duration of time they represent. That must be inferred stratigraphically. But such an inference assumes a valid record. If there is not one, then confidence decreases. The extent to which unconformities or 'gaps' permeate the strata correlates to uncertainty in that record. Miall noted:

> "'Only one-sixth of time is recorded' by sediments (Barrell, 1917, p. 797). This demonstration of the significance of missing time in the geological record has largely been ignored until recently. Modern stratigraphic charts show the major, recognized breaks, based on paleontological or structural data, although commonly these charts are drawn using an arbitrary and variable scale for the time axis, which under-represents the significance of missing time. The pervasive nature of minor breaks, and the generally fragmentary nature of the sedimentary record is typically not part of the description or interpretation of stratigraphic sections."[15]

Bailey and Smith introduced a quantitative method of evaluating completeness using gamma ray logs.[34] They showed a statistically significant correlation between the thickness of layers and the frequency of occurrence and that unconformities occur at every scale. Reed noted:

> "Bailey and Smith demonstrate that the application of statistical methods to measurements made from natural gamma ray logs yield information about the rocks undreamed of by Lyell, Cuvier, or any of the 19th century 'fathers' of the science. One way of seeing the meaning of their work is to see it as the liberation of sedimentology from stratigraphy. This is pertinent for Flood geology because today's methods allow a more rigorous examination of the Flood from a sedimentological/hydrodynamic point of view. If the movement of water occurred in similar ways across a wide range of scales, then the self-similarity of sedimentary layering and hiatuses may have been a natural outgrowth of the Flood and a way to help us understand it."[35]

Unconformities, then, also offer a means to critique uniformitarianism on its home field, showing that most of the 'record' is missing and it is thus far less credible and confidence-promoting than geologists believe.

Diachronous vs synchronous boundaries

Uniformitarians pay lip service to diachronous erosional surfaces (a surface where some deposits above the surface are older than some deposits below), because the time during which the erosion took place is typically less than field stratigraphic discrimination or is constrained within large stratigraphic intervals. Diluvialists, however, are constrained by the relative ages of boundaries; one day in the Flood might represent significant deposition or erosion (figure 4). Modern events demonstrate rapid erosion and deposition. Storms, tsunamis, eruptions, turbidity flows, and river flooding all indicate that significant sedimentation and erosion can occur in very short time periods. During a global Flood, this effect would be magnified, and the geographic scale would be global, not local:

> "The Flood shatters the illusion that time is the key to stratigraphy, focusing attention instead on the effects of widely varying tectonic and hydraulic energy levels on depositional environments, and on widespread diagenetic effects on those rapidly-deposited rocks."[36]

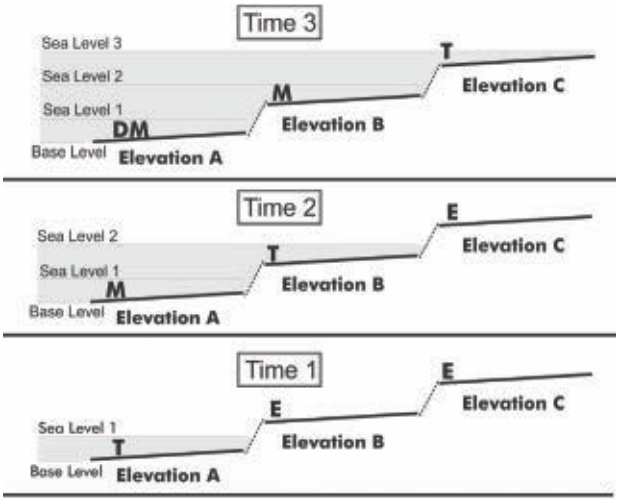

Figure 4. Cross-section of large region during Flood transgression from left to right showing how topography would cause different processes at the same time in a transgressing marine front (breaks inserted to shorten geographic scale). Time 1 = erosion (E) at higher elevations (B and C), while transgressive deposits (T) cover Elevation A. Time 2 = erosion at Elevation C, while transgressive deposits move to (B) and deeper marine deposits (M) cover the transgressive deposits at Elevation A. Time 3 = transgressive deposits cover Elevation C, *at the same time* as deep marine facies (DM) are deposited at A. The resulting record would show a large erosion surface covered by sedimentary units, T, M, and DM, but none are synchronous.[37]

Towards a more actualistic understanding

Actualism proposes that observed processes form the only valid analogies for historical explanations. But actualism is impossible in the dimension of time because the length of human observation is infinitesimal with respect to deep time. Furthermore, geologic processes are scale-dependent; the result of the flow of 100 gallons of water across a location is much different from the flow of 100 million gallons. Geologists cannot deny evidence of large-scale processes in the rock record, but act in cognitive dissonance as if these 'rare events' are the exception rather than the rule. Flood geology offers a different kind of 'actualism'. Although its processes were physically of greater geographic scale and intensity, underlying hydraulic principles allow quantitative assessment.[38]

Likely explanations for unconformities during the Flood

Diluvialists see *nonconformities* as nothing more than the deposition of sedimentary rocks on igneous and/or metamorphic rocks. For example, the Great Unconformity occurs at the base of the horizontal sequence in Grand Canyon, and rests mostly on igneous and metamorphic rocks (figure 5). It likely represents an early-Flood planation surface,[39] and its regional nature is seen in its occurrence in Wyoming and south-central Montana (figure 6). *Paraconformities*, if real, would represent short breaks

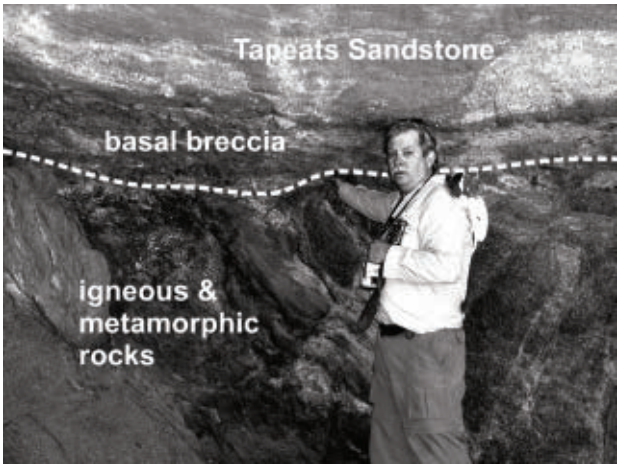

Figure 5. The contact between the igneous and metamorphic rocks of the upper crust and the flat lying Tapeats Sandstone at the bottom of the Grand Canyon (dashed line). Note breccia at the base of Tapeats.

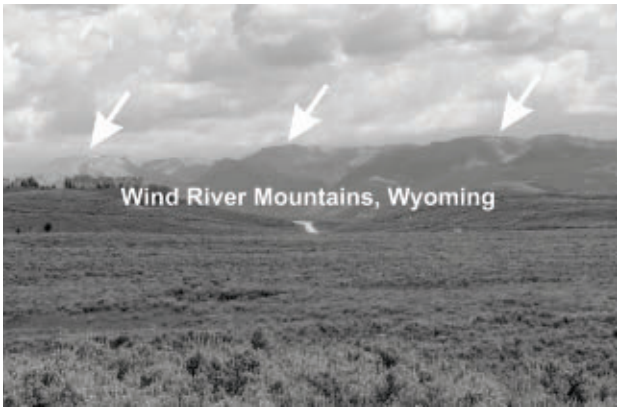

Figure 6. Great Unconformity at the top of the Wind River Mountains of Wyoming. View is to the east.

in continuous sedimentation, or possibly short time intervals between successive tsunami-like wave sets. *Disconformities* and *angular unconformities* would have been caused by rapid erosion, often accompanied by rapid tectonic changes.

Unconformities at Grand Canyon

Old-earth proponents identified 19 unconformities at Grand Canyon,[40] and claim such unconformities cannot be explained by Noah's Flood:

> "Multiple unconformities in a sequence of rocks, such as in the Grand Canyon, are impossible to reconcile with a single catastrophic event, which is why flood geologists work so hard at discounting the presence of all but the most obvious ones."[41]

Their assertion ignores modern hydraulics and sedimentation, and assumes the stratigraphic approach and its associated biostratigraphic and radiometric dating methods: "In the case of sedimentary rock in places like the Grand Canyon,

estimates are based largely on a comparison of the local fossil record with the global record."[42] This circularity flows not from empirical observation, but from assuming deep time, uniformitarianism, and evolution. They admit that 75% of deep time is missing in the Grand Canyon record (including the Precambrian), as compared to the geologic timescale. The Great Unconformity supposedly represents a billion-year gap. This angular unconformity, as well as others like Siccar Point (figure 1), can be explained by rapid uplift and erosion during the Flood (figure 7). The base of the Tapeats Sandstone above the Great Unconformity is a thin layer of breccia, indicating energetic flow. Since the Tapeats Sandstone can be traced hundreds of kilometres, it seems likely it was formed by widespread energetic events. Furthermore, Flood geologists welcome investigation of these unconformities; if so much of the record is missing, how can we trust the interpretation of uniformitarian geologists?

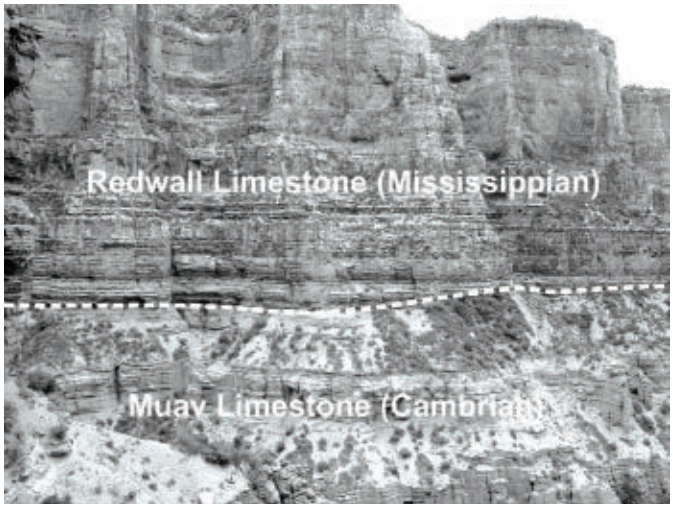

Figure 8. Contact between the Redwall and Muav Limestones supposedly represents about 160 Ma, but it shows little erosion (from the North Kaibab Trail).

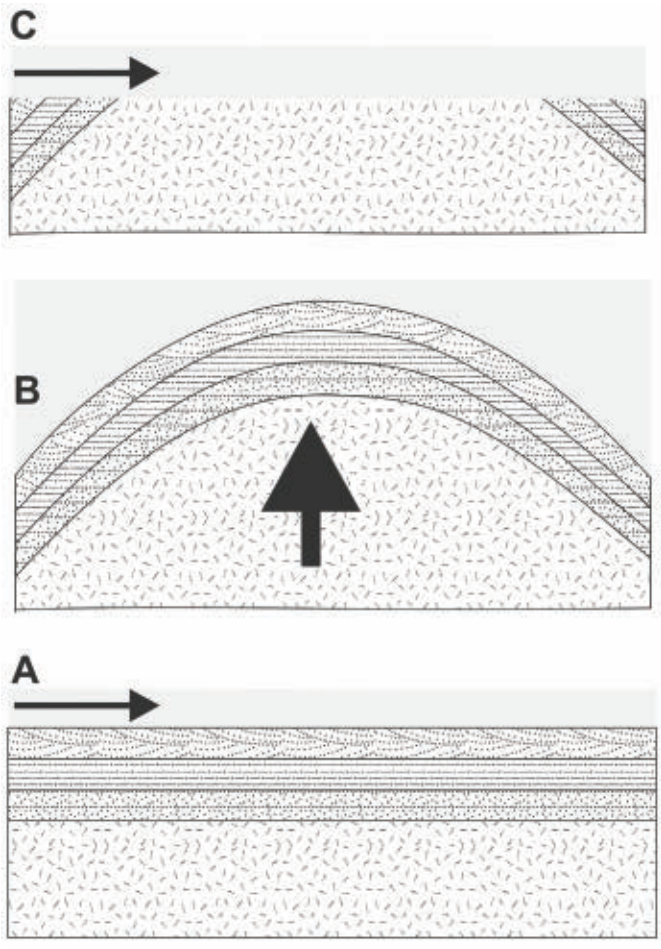

Figure 7. After deposition of strata by Flood (A), uplift would fold those strata (B), and subsequent erosion would create angled beds (C). If covered by later layers, an angular unconformity would be created.

Of those 19 unconformities at Grand Canyon, 10 are disconformities (figure 2b) showing gaps of up to many millions of years, like that of 160 Ma between parallel beds of the Cambrian Muav Limestone and the Mississippian Redwall Limestone (figure 8). In addition to fossil changes, the Grand Canyon disconformities are physically identified by weathering of the overlying layer, channels in the lower layer, and karst features on the top of the lower layer when it is carbonate. However, the 'weathered rock in overlying sediments' example of Hill *et al*. is the basal Surprise Canyon Formation within channels on the top of the Redwall Formation.[43] But the Surprise Canyon Formation is equally well explained as a depositional lag within a channel carved by a linear increase in flow velocity. The time required for its deposition is a factor of current size, depth, velocity, and sediment source. To call it 'weathering' is another example of uniformitarian circular reasoning. A similar example is found at the base of the Surprise Canyon Formation.

The Temple Butte Formation comprises channel fill deposits at the top of the Muav Limestone, and the Surprise Canyon Formation comprises channel fill atop the Redwall Limestone. These channels are thought to represent ancient fluvial systems. Channels and the channel fill (figure 9) are actually rare in the Grand Canyon,[44] but could have been easily and rapidly formed during the Flood by relative changes in the local base level, creating channels that were subsequently filled in. These channels rarely exceed 120 m in depth. Erosion into the Redwall and Muav Limestones indicates a degree of cementation. This is not surprising, since limestone *is* a cementing agent.

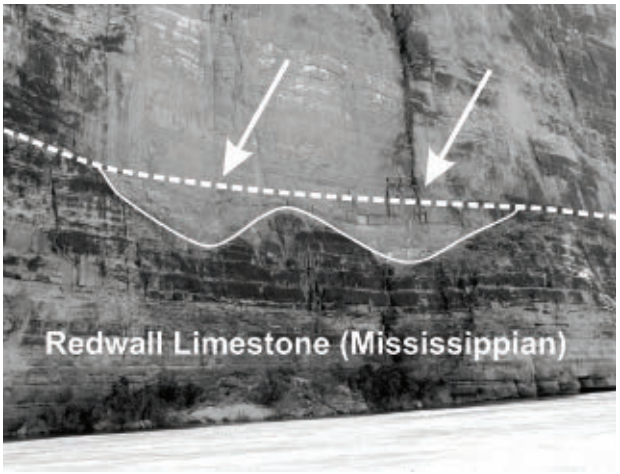

Figure 9. Small double parabolic scour within the Redwall Limestone (courtesy of Tom Vail)

Much ado is made of the channel fill yielding plant fossils at the base and marine fossils at the top: "This is possible only if the Redwall Limestone was above sea level for an extended time and was later submerged."[45] However, time is only in the minds of uniformitarians; plant matter was present in floodwaters. The interpretation of a river system is a uniformitarian interpretation, no more and no less. If the channels and their fills are from an ancient river, why are there not breccia layers at all levels of the fill and not just at the base? That suggests a single event of erosion and deposition.

The 'karst' at the top of the Redwall Limestone consists of collapse features (sinkholes) that are filled with the same sediments as found in the channels. There are also caves found in the formation that might have formed after sedimentation. The features are considered paleokarst, and are believed to have formed over a long time in a subaerial environment. However, such features can be produced by the Flood, by hydrothermal flows or gas seeps.[46,47] The area could also have been briefly exposed above the floodwater in which the so-called paleokarst features formed in a matter of days:

> "It is likely that the rapidly accumulating Flood sediments periodically emerged. The resultant degassing and dewatering of waterlogged sediments, along with the associated chemical changes, would have developed a wide range of negative relief in a matter of days."[48]

So, the observed features of the rock record, including unconformities, can readily be explained by the Flood. Only the Flood explains the lack of physical erosion within large-scale, flat-laying strata—which is typical of the rock record.[49] In either case, unconformities are significant. For uniformitarians, they are convenient places to place the millions of years not actually seen in the rocks. For creationists, they are indicators of the hydraulic and tectonic environments of the Flood.

Conclusion

Unconformities represent erosional events in the rock record. Uniformitarianism emphasizes the supposed time duration of unconformities, and uses unconformities as repositories of the deep time not recorded in strata. Diluvial geology should instead focus on the mechanics of the actual event, recognizing that the larger scale of extent and intensity better defines the surfaces.

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The self-regulation of growth problem for natural selection

Jerry Bergman

The core of Darwinian theory is that more animals are born than a land area can typically support, producing competition for limited resources, including food and mates. As a result, competition will occur between the more fit and the less fit. In the end, the more fit will be more likely to survive and pass their genes on to their offspring. The result is the law popularly termed survival-of-the-fittest, which is the main engine of evolution according to Darwinism. However, field research has documented that most mammals, and other animals as well, self-regulate their population in such a way that largely negates the Darwinian survival-of-the-fittest law and thus falsifies the main driver of evolution.

It is a common belief that when a community of animals becomes overcrowded, competition for food and other resources significantly increases. This competition causes Darwinian survival-of-the-fittest struggles, which is the basis of evolution.[1] However, this view vastly oversimplifies the situation. Field research finds that, in general "Animal populations fluctuate in numbers, but the fluctuations occur within definite limits" primarily through self-regulation.[2] One who spent a lifetime researching this problem was University of Aberdeen professor V.C. Wynne-Edwards (1906–1997; figure 1). As a naturalist, he collected a massive amount of evidence from his nature studies that he published in his now classic book on population control. He studied mammals, insects, birds, and plankton.[3] The conclusion of his lifetime of research was that most "animals control their population density at a sustainable level, responding to available resources and limits".[4] They achieve this goal by

> "… spreading themselves out, by limiting litter size (what we might call 'birth control'), and by territorial cues that signal other individuals of their species to respect their property claims. Some beetle species turn to cannibalism when crowded, and though lemmings don't actually jump off cliffs, they do respond to crowding by exploration en masse, and may die in transit."[5]

Mitteldorf and Sagan concluded that the "facts collected by Wynne-Edwards in support of natural population control are manifold and compelling". Furthermore, the "breadth of examples looks even more impressive fifty years" after he published his research. Examples include the fact that whales and elephants have very low mortality rates, and consequently

> "… reproduce much less frequently than their physiology permits. Lions and tigers spend much less energy on reproduction than smaller cats, … because they live so much longer that they would overpopulate if they reproduced more frequently. Flies bred in jars will reach a limited density and then cease to lay eggs, even if plenty of food is provided. Beetles eat their young in conditions of crowding. Mice and other rodents respond to crowded cages by refusing to reproduce, even when they have plenty of food, becoming pugnaciously territorial. Although Wynne-Edwards spoke of density-dependent population control for 'the good of the species' in a way that bridled the selfish gene assumptions of the Neo-Darwinists, these examples are not lightly to be dismissed."[6]

In other examples, when game fish are bred in tanks, the fish population

> "… remains remarkably constant whether a proportion of the fish is periodically harvested or their tank is left undisturbed. Long-lived birds—penguins, auks, condors, vultures, eagles, albatrosses—lay only one egg at a time, even when the physiological burden of producing an egg is trivial. In fact, if the one egg is lost or broken, the bird will replace it … . If the birds can lay two eggs so easily, what stops them from doubling up in Darwin's lottery?"[7]

Wynne-Edwards found that the strong territorial and hierarchical tendencies also resulted in the same density-dependent controls. His predecessor, Sir Alexander Morris Carr-Saunders, compiled a book a generation earlier that was limited to anthropological examples of self-population control. For example, Carr-Saunders found that hunter-gatherer populations were stable for thousands of years before agriculture. The many ways he found overpopulation was avoided included fertility limits, abortion, warfare, mating modifications, and even infanticide.[8] These behavioural responses were triggered for sustainability at the expense of achieving maximal reproduction levels. Mittledorf and Sagan concluded that in

> "… the context of neo-Darwinian theory, population control is just as impossible as programmed gain. But

> animals in the wild must have been playing hooky the day that theory was covered. Wynne-Edwards offered a compelling barrage, six hundred pages of evidence for natural population control … [and] the field of evidence in Wynne-Edward's book was never refuted, it became highly unfashionable to talk about the evolution of population control."[9]

Billington, in her textbook, *Understanding Ecology,* wrote that Darwin's struggle for existence and survival-of-the-fittest worldview is contradicted by the fact that

> "A careful observation of a community shows that plants and animals live together in agreement. Every living thing has a will for life to go on. People have the mistaken idea that animals in natural community are enemies. People believe that predators … are waiting—ready to snatch every passer-by. Ethology … the study of an animal's normal behavior, shows that this is not true. Both plants and animals appear to avoid direct competition with others if it might injure or kill them."[10]

She added that due to the enormous inbuilt 'will to live', all living things

> "… 'cooperate' as well as 'compete' with each other. When life is carried on normally in a community, the members live peacefully together. Often one will alert another to a common danger. You can observe this in a city park or street or in a suburban garden where pigeons, sparrows, starlings and other birds live together."[11]

Furthermore, she observed that there may exist

> "… some 'pecking' at the smaller birds who come to feed, but it is not a fight to the death. Watch chipmunks or squirrels feeding and chasing, and you will soon realize that much of the chasing seems to be in fun. If a real fight should develop, the other animals in the area show great concern even though they are not involved."[12]

Animals forced into unnatural situations by humans, such as the thousands we crowd in stockyards together before slaughter, tend to physically align themselves in rather ingenious ways so as to *reduce* conflict. For example, many birds position themselves quite evenly in a pen with respect to the other animals, and those towards the periphery face outward so as to utilize the 'facial distance' in front, and also to provide more facial distance to those animals towards the centre of the pen. Another method described by Krutch is to form a 'truce', such as

> "… when two wolves threaten one another the less aggressive often turns his cheek. This is not a signal to the other one to move in for the kill. The wolf who turns his cheek asks for a truce, and though the snarling continues, the truce is always granted. Turning the other cheek, the wolf teaches us, is not abject surrender but an honorable way to prevent a fight and save the species."[13]

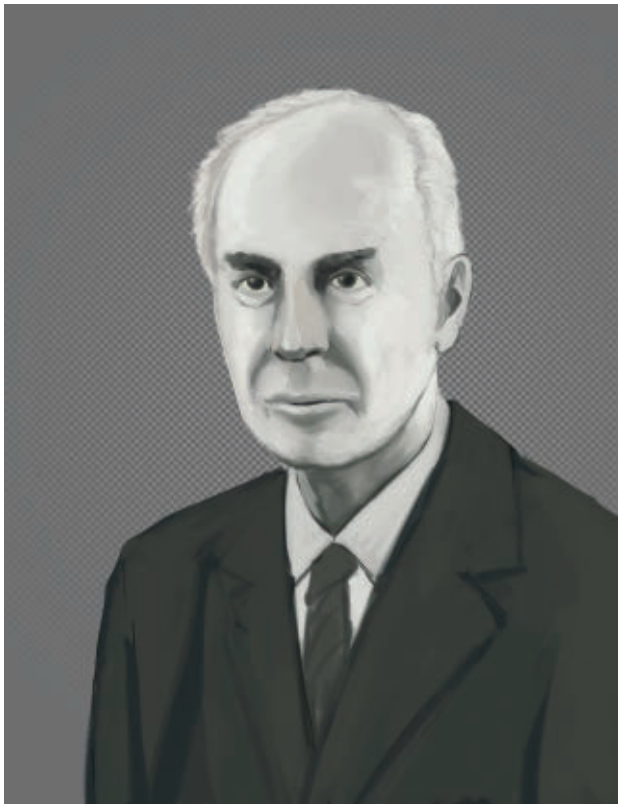

Figure 1. Professor V.C. Wynne-Edwards, who spent much of his life documenting the fact that many animals effectively self-regulate their population size

A study of internal population control

The classic example of an internal factor that limits population growth was by Christian.[14] In the early 1950s he studied the Sika deer (figure 2) population of James Island, a half square mile territory located in the Chesapeake Bay. Five Sika deer were originally imported to the island in 1916. Forty years later, when Christian began his fieldwork, the herd had grown to about 300. Two years after his arrival, the deer began dying off in astonishing numbers for no apparent reason. Over half died within just three months, and by the middle of 1959, only 80 deer were left.[15] Then, as mysteriously as the deaths began, the dying ceased. Research into the cause of these deaths included an examination of their feeding habits, and the possible presence of such factors as disease and toxin exposure.

None of the reasons that he researched could explain either the beginning or the ending of the deaths. A detailed study of their internal organs revealed that *only one difference existed* between the deer that died during the massive deaths in 1959 and those that perished from natural causes: an enlarged adrenal gland. In some cases, it was nearly *twice* as large as

Figure 2. The Sika deer of James Island, Maryland, the animal used in the classic study that helped researchers understand one means of instinct population regulation

in those deer that had died at other times. The researchers concluded that the deer had died due to *psychological overcrowding*.

From our viewpoint, the deer were not overcrowded—each one had over an acre of space. But that was evidently enough 'overcrowding' to produce the conditions that caused major enlargement of their adrenal glands, which in turn flooded the deer's systems with adrenalin hormones, causing brain and kidney hemorrhaging. Because deer are non-aggressive animals and cannot reduce their number by fighting, their only response to overcrowding was an innate physiological mechanism that lowers the population level until it reaches an ideal number. As this number was well above the animal's survival requirements, this mechanism would not be a result of natural selection. Furthermore, considerable evidence exists from both

> "… the field and the laboratory that crowding in higher vertebrates results in enlarged adrenal glands, which are symptomatic of shifts in the neural-endocrine balance that, in turn, bring about changes in behavior, reproductive potential, and resistance to disease or other stress. Such changes often combine to cause a precipitous 'crash' in population density."[16]

For example, at the peak of density, snowshoe hares often suddenly die from 'shock disease'

> "… associated with enlarged adrenals and other evidence of endocrine imbalance. In the cyclic insects … on the upswing of the cycle, tent caterpillars (*Malacosoma*) build elongated tents that are shifted about, and the individuals are active in moving out into the foliage to feed. At peak density, the caterpillars become inactive … feed less, and are more subject to disease … . Such adaptation syndromes would certainly seem to be mechanisms for 'dampening' oscillation so as to prevent too great a fluctuation that might damage the ecosystem and endanger the survival of the species."[17]

The tendency to expand up to a certain population level per square mile, and then triggering an internal mechanism to drastically reduce the population, may at first seem non-functional, but necessary to allow the animals to achieve a certain *quality of living*. It is assumed that a mechanism such as this is one way of controlling the population. A creationist would interpret this response as the Creator's way of insuring, not just survival, but adequate survival for the remaining animals; not just life, but a good life. While an

Figure 3. The lemming, one of the most well-known examples of population regulation by what amounts to their mass suicide

acre of land could easily support many more than one deer, it generally does *not* insure a high-quality life, but many, slightly undernourished, yet adequately surviving animals. This mechanism helps to insure *healthy, well-fed, strong animals.* It is not yet known how common this mechanism is, but it is evidently present in many non-aggressive animals.[18]

Newer studies have reinforced these findings, adding other factores involved in the self-regulation of populations.[19] All of the self-regulation systems, commonly known as instincts, "require intrinsic behavioral mechanisms that prevent or at least retard population growth prior to the population reaching food limitation".[20]

Mass suicide

The self-preservation instinct is perhaps the most basic drive found in all living things. Some creatures, such as lemmings (figure 3), frequently commit mass 'suicide', evidently for reasons similar to those that cause Sika deer to commit physiological suicide. When food is plentiful, these mouse-sized rodents with long silky fur lead lives high in the mountains in the icy regions of northern Scandinavia. They flourish on reindeer moss and various roots, and live in cozy underground nests. McFarland noted that, after a few years or so, the lemming population can grow to the level that their food supply is no longer able to sustain them. At this time

> "… the lemmings leave their burrows ... . Like an army heading for a great battle, they swarm out of the highlands and rush downward over the sloping plains. Normally, lemmings fear and avoid water. But, during their mass march ... the lemmings finally reach the seashore, and then, row upon row, plunge headlong into the water!"

The result was the rodents remain afloat for a short time, but soon tire and then

> "… one by one sink to their doom. During a lemming migration, the bodies of the animals can completely cover the surface of the water. One steamer off the Norwegian coast reported that for a full hour the ship had to cut its way through a thick shoal of lemmings swimming out to sea—swimming out to die!"[21]

Why they respond this way is still being debated, but such population control behaviour is a major reason why "very few parts of the earth are in any way crowded with animals".[22]

Calculated by weight, only a few pounds of birds normally live in an acre of land area, and the density of individuals per square mile is typically well below the land's support level. When seen as a flock flying south for the winter, or on an island which serves as a stopping or resting place, it appears that millions of birds live in crowded places. These animals, though, normally live in a very large area.

Although in some areas animal and plant life appears 'crowded', this is often primarily due to human interference. Humans have cut down forests, built farms and cities, and spread rapidly throughout the earth. Historically, at least in modern history, this has been the major disrupting factor in the natural world.[23] Thousands and sometimes millions of birds living in a fairly small area, rarely fighting and displaying little overt competition for food, is common.

If the population increases beyond a 'comfortable' level, the members often may simply spread out to a wider area. When this cannot be accomplished, they may slow down their reproduction rate or, for the reasons discussed above, many will die. This mechanism results in maintaining a certain level of animals living within a given area. The natural selection theory developed by both Charles Darwin and Alfred Russel Wallace were inspired by Malthusian (figure 4) doctrine, a thesis which is largely false.[4] Nonetheless,

> "Darwin and Wallace saw in the Malthusian doctrine a natural law which must apply to all species, and so they deduced that through competition for a limited resource, food, selection must take place between fit and unfit. The Malthusian logic seemed inarguable ... . And undoubtedly supply of food places a theoretical limit on animal numbers, just as there must be cases in which deficiencies of quantity or quality of food contribute to a limiting effect."[24]

Ardrey goes on to add that this view does not result in a theory that is better supported

> "… than that of the self-regulation of animal numbers. Rare is the population that has ever expanded until it reached the limits of food supply. Rare are the individuals who directly compete for food. An infinite variety of self-regulatory mechanisms, physiological and behavioral, provide that animal numbers—except in the case of climatic catastrophe—will never challenge

the carrying capacity of an environment. Birth control is the law of the species."[25]

Evidence that certain areas can support a far greater number of animals than usually exists is also demonstrated by animal domestication. Farmers have been able to graze horses, cattle, and sheep comfortably on an area of land at a density level that one rarely finds in nature. The fact that most land areas can support far larger populations of animals than are usually found in the wild clearly demonstrates that the numbers and types of animals are often *not* being held down by competition. Nor does nature normally overpopulate but, for many reasons, the number of animals is typically far less than a given area could support.

Except for humans, species that tend to populate an area to a greater extent are often not more evolutionarily advanced or much different from other species. Mice, gophers, and rabbits exist in comparatively large numbers per square mile, whereas far fewer anteaters and porcupines usually live in the same space. This may also be one reason why big species are relativity rare.[26] No evidence exists that the mammals which are more numerous are in any way physically more evolved or evolving, as would be expected by neo-Darwinism's survival-of-the-fittest concept.

The crowding problem

Admittedly, some examples of aggressive animals exist that fit the picture that Darwin felt nature as a whole exhibited.[27] However, even the better examples, such as rats, at best provide mixed evidence. Both human overcrowding in cities and the poor sanitary conditions such as those in city slums have influenced rodents to behave unnaturally. Rats living in the country typically do not exhibit the aggression typical of city rats. Even so, such crowding and the accompanying viciousness that they exhibit is characteristic of very few animals in the wild, even in crowded conditions.[28] This research also has direct relevance to the problem of the effects of stress on humans.[29]

Another example of self-regulation is that during times of food scarcity, Deer mice mothers consume less food[30] and, "How much a mother eats pre-sets the appetite of her offspring. This effect seems to help keep populations of wild animals stable, and may help them to avoid extinction."[31] Another study found that, although the population fluctuates, when the Arctic ground squirrel population has reached a certain level beyond that which the environment can no longer comfortably support, the females severely reduced their reproduction level, thus controlling the population.[32] Furthermore, the regulation that occurs is triggered mainly by the number of fellow squirrels that are in its environment.

So many examples of self-regulation exist that over 50 years ago Wynne-Edwards concluded that these findings could be generalized, and newer studies have supported his conclusion.[33] Tamarin studied a variety of self-population regulation systems, concluding all were determined by innate behaviour.[34] Field research by Lidicker found various self-control regulations in a variety of small mammals.[35] Lastly, Grant found similar mechanisms in carnivores, ungulates, and primates.[36] Many more studies could be cited that found the same behaviour self-population regulation, but this sample only further documents the findings of all those other studies reviewed.

Figure 4. Thomas Malthus, whose prediction that population growth would outstrip the food supply, misled both Darwin and Wallace. From this idea came the struggle-for-existence theory that produced survival of the fittest as a result of the struggle for resources, thus evolution.

Summary

This review documents the fact that many animals self-regulate their population, thus often avoiding the overcrowding problem.[37] Nor does a constant struggle exist in the natural world as Darwinism requires, but rather co-operation is often the norm. All other factors being equal, the larger the population, the more opportunities that exist for mutations to occur, and thus, in theory, Darwinian evolution would be more likely to result. Yet, those species blessed with far greater numbers do *not* seem to be more capable of

survival or outwitting their competitors or predators when compared to those that have less dense populations per square mile. These findings both go directly against Darwinian nature's tooth and claw survival-of-the-fittest theory.

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Making some sense of Babel and afterwards

Paul J.N. Lawrence

The statements made about language in the early chapters of Genesis are summarized before looking at the 'Tower of Babel' and the confusion of languages that resulted. A brief survey of the world's main language families is presented together with a rudimentary look at the phenomenon of language 'isolates' and the sheer variety of grammatical structures. This article focuses on the Semitic and Indo-European language families and considers some Hebrew nouns where connections with other families are evident and others where they are not. Historical linguistics says that each word tells its own story, but what can we learn from that story?

The single language referred to in the early chapters of the book of Genesis (11:1) and spoken by the inhabitants of the world from Adam to the Tower of Babel is fertile ground for speculation. Even some scholars, who would not give much credence to these chapters, postulate a proto-world language, with cognates[1] between widely different languages sometimes cited as evidence of an original language. For example proto-Indo-European **deik*[2] 'to point', hence Latin *digitus* 'finger' and Greek *deiknumi* 'to show' can be compared with Eskimo *tik* 'finger', Nilo-Saharan *dik* 'one', proto-Austro-Asiatic **tak* 'one' and Turkish *tek* 'only'.[3]

The early chapters of Genesis make several important points about the world's first language that can be summarized here:

1) Adam named every living creature that God brought to him (Genesis 2:19), but on what basis? Did he just invent a combination of sounds or did he try to describe the creature before him, in which case in what language? Did this mandate extend to other areas too and were any of these terms preserved in later languages?

2) The Table of the Nations (Genesis 10:1–32) divides the peoples of the world into three groups—the descendants of Noah's sons Japheth, Ham, and Shem. A total of 70 nations are listed. There is no simple link between descent from a particular son of Noah and language, but generally speaking Japheth fathers the Indo-European-speaking peoples, Ham, the Hamitic-speaking peoples and Shem, the Semitic-speaking peoples.[4]

3) The story of the Tower of Babel in Genesis 11:1–9 gives an explanation for linguistic diversity and makes three basic points:

a) Originally there was just one universal language (11:1).

b) When the Lord confused the language of the people, new languages were miraculously generated. What and how many of these new languages there were is unknown, but the result of the LORD's action was clear—confusion (11:9), the people were unable to understand each other and so scattered over the face of the whole earth.

c) The location of this incident is placed in Shinar which may be the land inhabited by the Sumerians, i.e. southern Iraq (11:1). The city, of which the tower was a part, was Babel ('confused'), the Hebrew word for Babylon (11:9).

4) Whatever language was spoken before the Tower of Babel, the writer (or compiler) of Genesis views that world from his later Hebrew perspective thus:

a) Adam means 'man' and also sounds like the Hebrew *adāmāh* 'ground'.
b) Cain (4:1) sounds like the Hebrew for 'brought forth' or 'acquired'.
c) Nod (4:16) means 'wandering'.
d) Seth (4:25) probably means 'granted'.
e) Methuselah (5:21) would seem to be a combination of the roots *mt* 'to die' and *šlḥ* 'to send', significant perhaps that according to Genesis' own chronology Methuselah dies in the year of the flood.
f) Noah (5:29) sounds like the Hebrew for 'comfort'.

It is evident that the writer of the early chapters of Genesis seems to enjoy 'playing with words' for literary effect.

Historical linguistics

Over the last 200 years or so linguists have developed a discipline that can be termed 'historical linguistics'. Where sound changes can be traced over the centuries in written texts the principles behind these changes can then be extrapolated back into the past to deduce so-called 'protolanguages'. The precise reconstructed forms of given words in protolanguages will often differ from scholar to scholar and sometimes the strange signs and symbols used seem to obscure rather than elucidate the sound changes that are being advanced.

Language families and isolates

In the modern world there are 7,102 known languages.[5] Most of the world's languages can be grouped into what are commonly called 'language families'. The largest 11 families are made up of over 100 languages each and account for 5,384 (75%) of the world's languages.[6] Smaller language

families account for a further 1,608 languages. A total 136 language isolates[7] are claimed, making up 32% of all the c. 420 language families known (figure 1).[8] The term 'isolate' is somewhat subjective. Sister languages in different regions of the world may exist, but may not have been identified. Furthermore, sister languages may have once existed, but are no longer spoken.

What is clear is that the vast majority of the world's languages are part of clearly definable language families. Behind each language family a proto language is posited, such as proto-Semitic and proto-Indo-European, but it needs to be stated that these are theoretical reconstructions, there are no texts of protolanguages, and linguists do not always agree on the forms that they posit.

It is noteworthy that although languages within a language family have many common features, surprisingly few of these features are shared with languages from another language family, suggesting that the protolanguages and progenitors of modern isolates arose at the original confusion of languages that the Book of Genesis records as happening at the Tower of Babel.[9]

The Semitic language family

We should briefly note the main languages that are in some way relevant to the study of the Old Testament. Hebrew, the language in which the vast majority of the Old Testament is written, belongs to what is called the 'Semitic language family'. This was so named by late 18th century linguists[10], after Noah's son Shem (Genesis 5:32), and was represented in the ancient world by:

1) Akkadian, a language spoken in Mesopotamia (modern Iraq) by the Assyrians and Babylonians.
2) Ugaritic, the language of a Syrian seaport.
3) Phoenician, spoken along the Mediterranean coast of Lebanon and Syria.

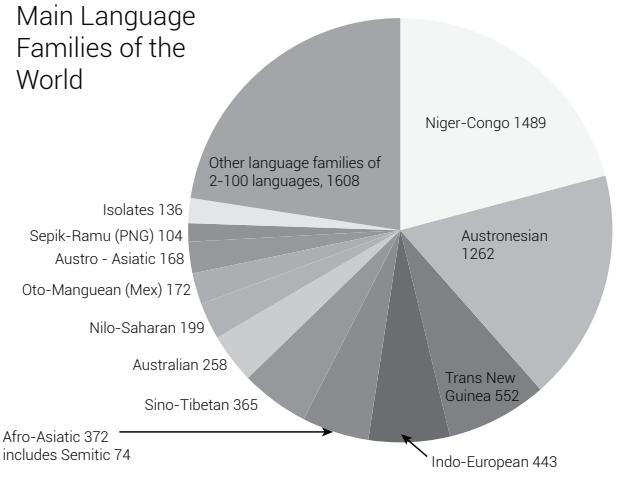

Figure 1. The main language families of the world

4) Aramaic, a language spoken in Syria (which became the official language of the Persian empire in which portions of the Old Testament books of Ezra and Daniel were written[11]) and the languages of Israel's neighbours—Ammon, Moab, and Edom.

In the modern world Arabic, Amharic, the language of Ethiopia, and Maltese are also part of the Semitic language family. All these languages seem to have originally stemmed from a single tongue, which scholars have termed 'proto-Semitic', but of which no texts have survived. Modern-day linguists would place the 74 languages of the Semitic family within a wider family[12] termed Afro-Asiatic, which has 372 identifiable languages.

The word plays evident in the early chapters of Genesis may have also worked in proto-Semitic (perhaps even in proto-Afro-Asiatic), but almost certainly would not have worked in another language family.

The Indo-European language family

Ancient languages such as Greek and its predecessor Mycenaean Greek, Latin, Old Persian, plus Hittite and several other languages of ancient Anatolia (modern Turkey) such as Luvian and Lycian, belong to the so-called 'Indo-European language family'. Such diverse ancient tongues as Armenian and Gaulish were also Indo-European. Avestan (spoken in Iran), Sanskrit (the ancient classical language of India), and Tocharian (once spoken in Chinese Turkestan and attested in manuscripts dating from the 6th–8th centuries AD) are other examples of what is now the most widespread language family in the world. It is of course the family that includes such widely spoken languages as English, French, German, Russian, and Spanish.

Approximately 45% of the world's population speaks an Indo-European language.[13] It would seem that all the 443 Indo-European languages from Portuguese to Punjabi and from Swedish to Sanskrit ultimately derive from the same source that scholars term 'proto-Indo-European', but of which, once again, no texts have survived.

Other language families within the wider biblical world

Sumerian, spoken in southern Mesopotamia (modern Iraq) and arguably the world's oldest attested language, has no relatives, either ancient or modern. It can thus rightly be classed as an 'isolate'.

Ancient Egyptian can be classed in the wider Afro-Asiatic language family, which was traditionally termed 'Hamito-Semitic'.[14]

Other language families, peripheral to the world of the Bible, include the Kartvelian (or southern Caucasian) language family, exemplified by modern Georgian, Svan, and Laz; the northern Caucasian language family, exemplified

by Ubykh (now extinct[15]) and Abaza, (Hurrian and Urartian, once spoken in eastern Anatolia (modern Turkey) may have been isolated or may have affinities with this group); and the Turkic language family which is part of a wider family known as 'Altaic'.

Variety in world languages

It is also worth noting just how much variety there is among languages and language families. Some features of biblical Hebrew contrast with many other languages. The seven examples given below are representative, not comprehensive. The first three can be illustrated from the Bible's first verse:

bᵉ-rēšît bārā ʿlōhîm ēt-haš-šāmayim wᵉ-ēt hā-āreṣ
"In (the) beginning created God the heavens and the earth."

1) The first word begins with *bᵉ-*, a preposition 'in'. Hebrew, like English, has prepositions before the nouns they govern. Other languages have postpositions, the equivalent of saying '(the) beginning in'.

2) In biblical Hebrew the standard word order in a sentence is verb, subject, object. Thus: verb 'created', subject 'God', object 'the heavens and the earth'. Other languages generally place the verb in the middle (as in English) or at the end (as in Turkish).

3) Hebrew marks definite objects with a marker *–ēt*, in this case *ēt-haš-šāmayim wᵉ-ēt hā-āreṣ* 'the heavens and the earth'. Many languages (e.g. Latin) mark subjects and objects with particular noun cases, whilst others (e.g. English) rely on word order to do this. But this is not the only way—a totally different system called 'ergative', found in some 21% of the world's languages, which marks the subject of an intransitive verb (a verb not having an object) in the same way as the direct object of a transitive verb. There may even be traces of an ergative in Hebrew.[16]

Other features of biblical Hebrew cannot be illustrated from the Bible's first verse, but are worthy of note thus:

4) Biblical Hebrew (like English) is non-tonal. This contrasts with a tonal language like Chinese where *ma* with a level tone means 'mother', with a rising tone means 'flax', with an end rising tone means 'horse' and with a falling tone is an interrogative.[17]

5) Hebrew, like other Semitic languages, is based around roots consisting of consonants, usually three in number. Normally vowels and affixes distinguish related meanings. Thus the root *špṭ* produces *šāpaṭ* 'he judged', *yišpōṭ* 'he will judge', *šōpēṭ* 'a judge', and *mišpāṭ* 'judgment'. In some other languages the root is followed by a series of morphemes that string together to mark different components of meaning. This is called an 'agglutinative language' (like Turkish). In other languages additions are made to the root (inflections) to mark noun cases and verbal conjugations (like in German or Latin).

6) Hebrew nouns have two grammatical genders—masculine and feminine. Adjectives also have separate masculine and feminine forms. Greek adds a neuter gender, but some language families such as Turkic and Kartvelian do not distinguish gender at all. Hebrew also distinguishes gender in the second person of the verb, which many other languages do not do.

7) Hebrew, like most languages, employs a decimal counting system (based on 10), but some languages use a vigesimal (based on 20) system.[18]

Which combination of these and other features was employed in the original language is indeterminable, but now we can only marvel at the diversity present in the world's languages.

No wonder the peoples of the world after Babel were confused!

Cultural borrowing

Many inhabitants of the Old World are aware that such well-known produce as potatoes and tomatoes[19] are examples of New World products being borrowed by the Old World—a process that is sometimes called 'cultural borrowing'. As peoples come into contact with plants, animals, substances, materials, or objects that were hitherto unknown to them the default position, it would seem, is to borrow the names by which they were already being called. It is not surprising then that one would expect to find examples of cultural borrowing too in the pages of the Hebrew (and Aramaic) Bible. A classic case is the list of musical instruments, written in Aramaic, repeated several times in Daniel 3, where the majority of instruments are clearly of Greek origin. So if Hebrew words can be shown to be cognate (representing the same original word or root) with words in other languages what does that tell us of the history of the words used in the Bible?

This brief study looks at nine examples of what may be cultural borrowing in the Hebrew Bible. All the examples are nouns and have been chosen because cognates can be clearly traced in other languages or other language families. Thus there are: two plants or plant products— 'apple' and 'vine/wine'; four animals—'horse', 'camel', 'elephant', and 'lion'; two metals— 'iron' and 'gold'; and a single manufactured article—'ship'.

It is of course possible that as speakers of Hebrew came into contact with plants, animals, substances, materials, or objects that were hitherto unknown to them that they borrowed such terms from the languages around—as English did with 'potato' and 'tomato'. However, as we have remarked earlier, the fact that Genesis 2:19 specifically states that Adam named every living creature gives the first man the mandate of naming the living creatures all around him.

Does the fact that the terms for 'iron' (Genesis 4:22) and 'wine' (Genesis 9:21) occur in descriptions of the world before the Tower of Babel suggest that the origin of these

words is in the language spoken before the Tower of Babel?[20] Are cases where the Hebrew word is cognate with an Indo-European word or a word from some other language family any indication of that word coming from the language spoken before the Tower of Babel? It may be significant that 'camel', 'horse', 'lion', and 'ship' first occur later in the book of Genesis (12:16; 47:17; 49:9, 13 respectively), so clearly they too are all 'early words'.

Let us now look at nine examples of possible 'cultural borrowing'. Most are from one language family to another. The items listed below are grouped according to language families with which the examples can be compared.

A. Semitic and Indo-European cognates

There are three examples of words being borrowed from the Indo-European family or of the Hebrew word being borrowed into the Indo-European family.

1) Ship

The common Hebrew term for 'ship' is *ᵒniyyāh*, cognate with Ugaritic *any,* and Egyptian *inaya* all of which may be traced to a proto-Indo-European ***nahw* 'to float', 'to sail' which in turn occasioned Greek *naus,* Latin *navis,* and Sanskrit *náuṣ*.[21] The common Akkadian term for 'ship' *eleppu* is clearly different (figure 2).

Figure 2. Words for 'ship' in languages of ancient and modern Europe and Asia

2) Gold

Hebrew has a number of different words for 'gold'.[22] One of the less common terms *ḥārūṣ* is used in Psalm 68:14; Proverbs 3:14; 8:10–19; 16:16, and Zechariah 9:3. It is cognate with Akkadian *ḫurāṣu* and Ugaritic *ḫrṣ* and would seem to have been borrowed by several Indo-European languages, e.g. Mycenaean Greek *kuruso* and Greek *chruso*. In Hittite *ḫarašu* came to mean 'bronze'.

Sumerian shows a different word in *guškin* which may be related to Armenian (*v*)*oski* and Finnish *vaski* (in this case = 'copper') (figure 3).[23]

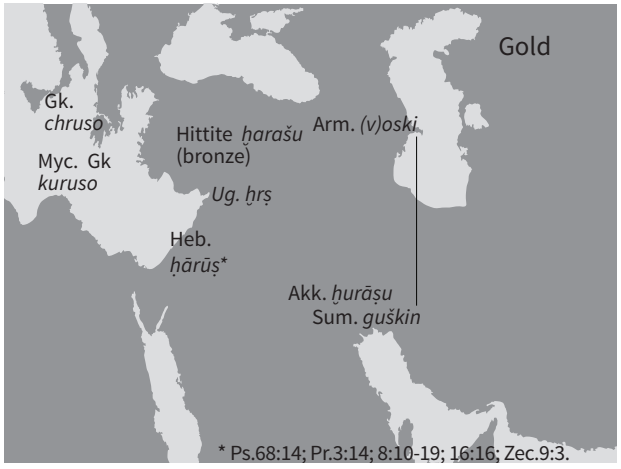

Figure 3. Words for 'gold' in languages of ancient and modern Europe and Asia

3) Lion

There are a number of different Hebrew words for 'lion' (*Panthera leo*), but the one selected here for discussion is *lābiy*, perhaps more exactly 'lioness'[24], which is cognate with Egyptian *rw(b),* Ugaritic *lbu*, and Akkadian *labbu.* The Indo-European terms illustrated by Hittite *walwa,* Mycenaean Greek *rewopi,* Greek *leōn*, and Latin *leo* may be related to Hebrew *lābiy*. However the common Akkadian term *nēšu,* the Sumerian *urmaḫ,* and Sanskrit *simha* are not related to the above or to each other.[25]

It is worth noting that in Old Testament times lions were not confined as at the present to Africa and India. Both Samson and David encountered them in Israel (Judges 14:5 and 1 Samuel 17:34 respectively) where the last lion was probably killed (near Megiddo) during the Crusades in the 13th century (figure 4).[26]

B. Semitic, Indo-European and even wider cognates

There are examples of cognates extending beyond the Semitic and Indo-European families, two perhaps into the languages of the Caucasus and one into the Afro-Asiatic family.

1) Horse

The Hebrew term *sûs* for 'horse' (*Equus caballus*) is cognate with Akkadian *sisû* and Egyptian *śśm.t.* But the cognates extend wider too into the Indo-European language family with the consonant *-s-* being preserved in Luwian *ásùwa*, Lycian *esbe*, Avestan *aspā*, and Sanskrit *áśvā*. It is generally proposed that all these forms are derived from the

proto-Indo-European **ekʰwos,* hence Mycenaean Greek *iqo* from an original **(h)i(k)kwo,* Latin *equus*, and Tocharian B *yakwe.* Greek has a change to *-p-* with *hippos.*[27]

Behind the proto-Indo-European **ekʰwos* a root **herh* 'to plough' is proposed.[28] Another proposal is a derivation from an Indo-European root **ōkú* 'swift'.[29] Alternatively the same meaning 'swift' is advanced from the northern Caucasian languages Ubykh *qá* and Abaza ʔʷ*əra* (from **ẋʷqʼʷeqʼə* 'to run').[30]

Of the major ancient languages only Sumerian is radically different with *anše.kur.ra* 'donkey from the (eastern) mountains' being first mentioned in a text of the Third Dynasty of Ur (traditionally dated to c. 2100 BC).[31] The horse is recorded as being present in Egypt during the time of Joseph (Genesis 47:17) (figure 5).

2) Vine / Wine

The vine *Vitis vinifera* (from the wild form *Vitis sylvestris*) produces grapes, which naturally ferment to produce wine. The Hebrew term for 'wine' *yayin* has clear cognates in several other Semitic languages, e.g. Ugaritic *yn* and Arabic *wayn* (meaning 'black grapes'[32]). A proto-Semitic form **wayn* is postulated with which one of the Egyptian words for wine *wnš.*(*t*) would seem to be cognate.[33] But the cognates extend far wider to the proto-Indo-European term **woino,* the supposed origin of Hittite *wiyana*, Mycenaean Greek *wono,* Greek *(w)oinos*, and Latin *vinum.* A proto-Indo-European root **w(e)i* 'to weave', 'to plait', 'to twist' describing the grapevine is advanced for this word.[34]

It could be that the vine originated in the southern Caucasus where grape pips in a carbonized or petrified state have been found at a number of so-called Neolithic sites.[35] Georgian *ǧvino* and Laz *ǧvini* from the southern Caucasian (or Kartvalian) language family are advanced as examples of a Caucasian origin for this root.[36]

It is interesting to note a detail from the Old Testament story of Noah. Following his disembarkation from the ark, which had landed on one of the mountains of Ararat (ancient Urarṭu, broadly modern eastern Turkey), Noah planted a vineyard and became drunk on the produce. (Genesis 9: 20–21).

However it should be noted that not all ancient languages borrowed this term. Egyptian *yrp*, Akkadian *karānu*,[37] and Sumerian *geštin* are clearly not related to the above (figure 6).

3) Elephant

The term for 'elephant' does not occur directly in the Hebrew Bible, but it is concealed in the twice-occurring phrase *šen habbîm* translated 'ivory' in 1 Kings 10:22 and its parallel 2 Chronicles 9:21. *Šen* is 'tooth' and *habbîm* a plural cognate with the Egyptian *3bw* and Sanskrit *íbhaḥ* 'elephant' and Latin *ebur* 'ivory'. Other Indo-European languages such as Mycenaean Greek *erepa,* Greek *elephas*, and Hittite *laḫpa* have cognates.

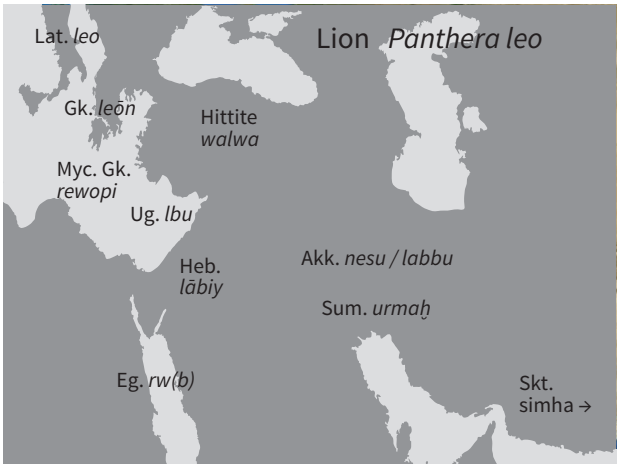

Figure 4. Words for 'lion' in languages of ancient and modern Europe and Asia

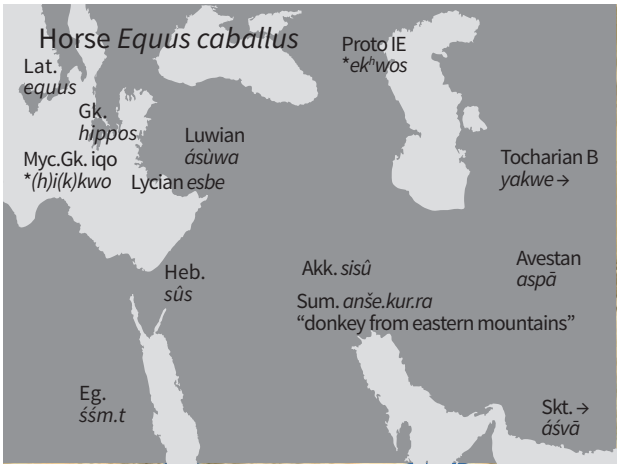

Figure 5. Words for 'horse' in languages of ancient and modern Europe and Asia

Five species of elephant were known in antiquity of which the African bush elephant *Loxodonta africana,* the African forest elephant *Loxodonta cyclotis*, and the Indian elephant *Elephas maximus indicus* are still extant. The Egyptian *3bw* may have been the term from which other languages borrowed—itself perhaps having been borrowed from a word such as **eḷu* in an unknown Hamitic (=Afro-Asiatic) language.[38] With the addition of the Egyptian definite article *-p-* and a shift of *-l-* to *-r-* the Akkadian *pīru* results. The *-l-* is retained in the Arabic *fil.*[38]

The now extinct Syrian elephant *Elephas maximus asurus,* which was a sub-species of the Indian elephant *Elephas maximus indicus,* is shown in a painting from the 15th century BC tomb of the Egyptian vizier Rekhmire in Thebes. An elephant is depicted on the Black Obelisk of the Assyrian king Shalmaneser III, found at the Assyrian city of Nimrud

and dating from 841 BC. The accompanying inscription says that Shalmaneser received his female elephants as tribute from Egypt,[39] suggesting that the elephant in question was the now-extinct North African elephant *Loxodonta africana pharaoensis* (figure 7).[40]

C. Where cognates are not traceable across language families

There are several examples where the above pattern does not apply. There is an example of cognates being limited to the Semitic language family, with several different terms being used elsewhere.

1) Iron

The Hebrew term for 'iron' is *barzel,* cognate with Akkadian *parzillu* and Arabic *farzilun,* but maybe there is a connection with the Sumerian *an.bar* 'sky-iron' = 'meteoric iron'[41] and the southern Caucasian Svan *berež* and Latin *ferrum.*[42] It is noteworthy that the languages of ancient Anatolia—the pre-Classical Middle East's main source of iron—Hittite and Hurrian have yielded a different pair of words *ḫapalki* and *ḫabalgi* respectively which are clearly cognate with another Akkadian word *ḫabalkinnu.*[43]

Iron was a luxury until the start of the so-called Iron Age, c. 1200 BC. There is however archaeologically attested limited use before, so for example an ivory box from Acemhöyük in southern Turkey, traditionally dated to 18th century BC is decorated with studs of gold, lapis lazuli, and iron (figure 8).[44]

There is an example of a Hebrew term that lacks clear cognates with either Semitic or Indo-European, but where some other surprising cognates are sometimes claimed.

2) Apple

Hebrew *tappuaḥ* 'apple' can only be directly related to Egyptian *tpḥ* from which it would seem to have been borrowed. A papyrus of the Egyptian pharaoh Ramesses II (traditionally dated 1279–1213 BC) discloses that the fields of the Delta were full of apples.[45]

Apples (*Malus pumila* derived from the 'crab apple' *Malus sylvestris*) are thought to have originated in the southern Caucasus.[46] It is worthy of note that 'apple' in the southern Caucasian language Laz *uškuri* would seem to be cognate with Sumerian *ḫašḫur* (and Akkadian *ḫašḫūru*).[47] These languages are separated by considerable geographical and chronological distance, so perhaps a borrowing from a hitherto unknown intermediate origin would seem likely.

Another pair of related words for 'apple' is Hurrian *ḫinzuri* and Armenian *ḫnjor.*

The reconstructed proto-Indo-European word for 'apple' **amlu*, has given rise to Greek *mēlon*, Latin *mālum* and Gaulish *avallo.*[48] A further oddity is that

Figure 6. Words for 'wine' and 'vine' in languages of ancient and modern Europe and Asia

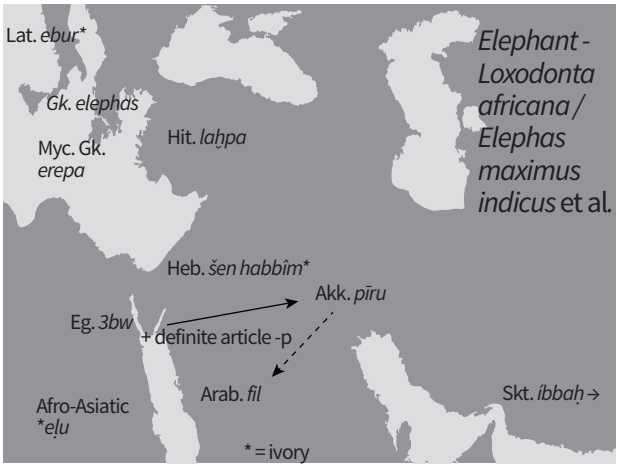

Figure 7. Words for 'elephant' in languages of ancient and modern Europe, Asia and Africa

Figure 8. Words for 'iron' in languages of ancient and modern Europe and Asia

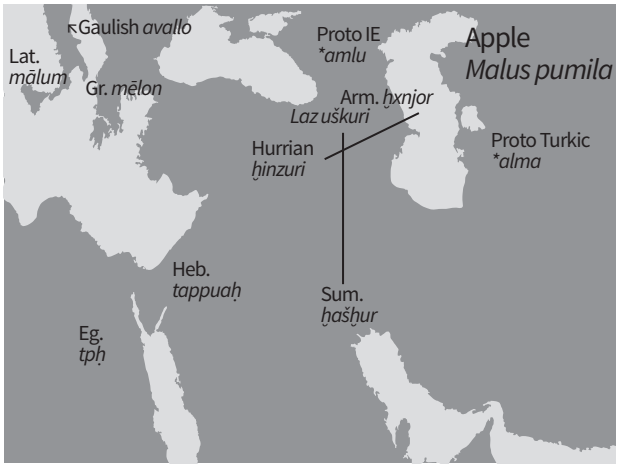

Figure 9. Words for 'apple' in languages of ancient and modern Europe and Asia

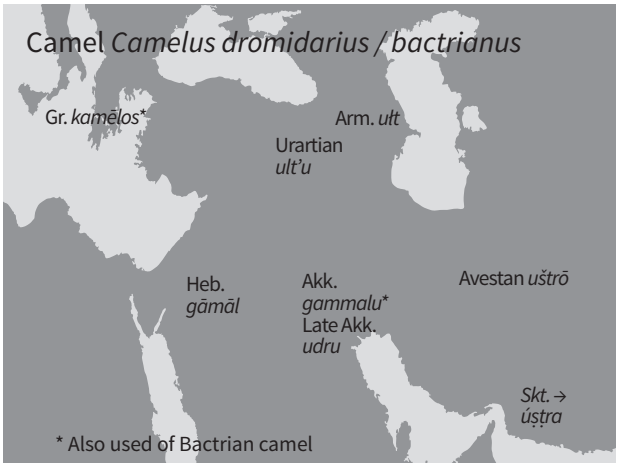

Figure 10. Words for 'camel' in languages of ancient and modern Europe and Asia

proto-Indo-European **amlu* is clearly related to the proto-Turkic term **alma,* suggesting a common borrowing at the proto-language phase (figure 9).[49]

And finally there is an example where different words, are used at least in part, to differentiate similar but distinct species.

3) Camel

The Hebrew term for 'camel' *gāmāl* would seem to designate the one–humped camel, the dromedary, *Camelus dromedarius.* It is cognate with the Akkadian *gammalu*, which was also used for the two–humped species *Camelus bactrianus.*[50] Likewise the Greek term *kamēlos* was also used for both species.[51] A different term was used for the two–humped Bactrian camel in and around its native habitat in Iran and Central Asia. Thus Urartian *ult'u*, Armenian *ułt,* Late Akkadian *udru*,[52] Avestan *uštrō*, and Sanskrit *úṣṭra.*

It is often claimed that there is little evidence for camels before their supposed domestication in the 12th century BC.

Table 1. Direction of borrowing of loan words between language families

Word	Hebrew word	Proposed original	Direction of borrowing
'ship'	*oniyyāh*	**nahw*	Proto-Indo-European to Semitic
'gold'	*ḥārūṣ*		Semitic to Indo-European
'lion'	*lābiy*		Indo-European to Semitic (?)
'horse'	*sûs*	**ekʰwos*	Proto-North-Caucasian (?) to Proto-Indo-European to Semitic
'wine' / 'vine'	*yayin*	**woino*	Proto-Kartvelian (?) to Proto-Indo-European to Semitic
'elephant'	**hab*	**eḷu*	Afro-Asiatic to Semitic to Indo-European

However considerable evidence is now emerging of camels being used before that date. Among the earliest pieces of evidence, there is a limestone carving of a camel found some 100 km south of Cairo, from Egypt's First Dynasty (traditionally dated to c 3100–2890 BC).[53] From Turkmenia in Central Asia there are Namazga IV period (3000–2600 BC) models of camels pulling carts.[54] Old Babylonian lexical texts from the 19th–17th centuries BC attest domestication and a Sumerian text from Nippur dating to the 19th–17th centuries BC refers to camel's milk (figure 10).[55]

Each word has a story

The data available to us is only partial and we cannot always be sure of the dating of written texts and which way any given word was borrowed (table 1). However, it cannot be denied that each word listed above has its own unique set of cognates and thus historical linguistics enables us, at least in part, to tell each word's story. It is certainly too much to claim that any of the words discussed above are from the world's first language, but each story is certainly worth telling. I hope this study has shown how some stories are similar to others, and will encourage further speculation as to why this might be so.

Finally, it is a curious 'historical accident' that the reason why 'apple' is often identified as the fruit with which the serpent tempted Adam and Eve is the fact that *malum* in the Latin Vulgate translation of Genesis 3:5 'evil' is, as we have seen, also the Latin for 'apple'.[56]

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2. * denotes a reconstructed form, signifying a form does not exist in any written texts.
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6. Unless otherwise cited, figures for languages are based on Grimes, B.F., *Ethnologue*, 14th edn, SIL International, Dallas, TX, 2000.
7. Campbell, L., *Historical Linguistics—Introduction*, 3rd edn, Edinburgh University Press, Edinburgh, pp. 166, 170, 2013; includes isolates now extinct such as Sumerian. Basque, spoken in south-west France and northern Spain, is an often quoted modern example.
8. Campbell, ref. 7, p. 168, which includes language families now extinct.
9. Some linguists however lump language families together to create macro families such as Nostratic, proposed by Holger Pedersen in 1903, comprising the Indo-European, Altaic, Uralic, Semito-Hamitic, and Eskimo families. This and other proposed macro families are discussed by Pereltsvaig, A., *Languages of the World—an Introduction*, Cambridge University Press, Cambridge, pp. 218–229, 2012.
10. Traceable to Johann Gottfreid Herder (1744–1803) and August Ludwig von Schlözer (1735–1809). Olender, M., *The Languages of Paradise*, Harvard University Press, Cambridge, MA, p. 11, 1992.
11. Ezra 4:8–6:18; 7:12–26; and Daniel 2:4–7:28.
12. Grimes, ref. 6, lists many Arabic dialects as separate languages.
13. Pereltsvaig, ref. 9, p. 12.
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15. Tevfik Esenç, the last speaker of Ubykh, died in Turkey in 1992. The language is of considerable interest to linguists as it has 80 consonants.
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17. Potter, S., *Language in the Modern World*, Penguin, London, pp. 120–121, 1960.
18. Traces of a vigesimal system are evident in the French 'soixante-dix' = 'seventy' and in the older English 'three score and ten'.
19. 'Potato' can be traced to Taino, a Cariban language of Haiti, and 'tomato' to Nahuatl, the language of the Aztecs of Mexico. Campbell, L., *Historical Linguistics—An introduction*, 3rd edn, Edinburgh University Press, Edinburgh, p. 57, 2013.
20. 'Gold' occurs too in Genesis 2:11 too, but this is the more common word *zāhāb*.
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23. Gamkrelidze and Ivanov, ref. 21, p. 618.
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29. Hamp. E.P., The Indo-European horse; in: Markley, T.L. and Greppin, J.A.C. (Eds.), *When Worlds Collide—Indo-Europeans and pre-Indo-Europeans*, Karoma, Ann Arbor, MI, p. 212, 1990.
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The genetic history of the Israelite nation

Robert W. Carter

In an earlier paper, I detailed the many intermarriages that are documented between the Jews in the Old Testament and the people groups around them. It was clear from this analysis that they began as a mixed people group and continued to mix with outsiders through the end of New Testament times. This has profound implications on the genetic patterns we should expect to be found among them today. Here, I outline multiple relevant lines of genetic evidence that demonstrate this mixing. Most of this genetic information is for events more recent than many of the episodes in the biblical narrative, but they illustrate the nature of populations that live in proximity to other people groups. It is clear that modern-day Judaism carries a core set of ancient lineages tracing back to the Middle East, plus a large fraction of newer genes brought in by more recent mixing. Is this core set of genes enough to conclude they indeed trace back to biblical times? Indeed so. This exercise should inform us about how 'races' form and what racial differences should exist among the people living on Earth today.

The Bible gives us a clear and detailed history of the Jewish nation. In fact, the biblical text may give us a more detailed ethnography for the Jews than we have for any other ancient nation. Detailed genealogical tables exist, and an unbroken history from Adam to Abraham and beyond is given to us with little to no ambiguity. But given that contemporary Jews descend from the biblical patriarch Jacob, how much of their genetics can be traced back to him? With thousands of years of history that includes migration, destruction, restoration, a 'Diaspora' that has never ended, and much intermarriage with non-Jews, what should the state of their genetics be today?

Ancient Jewish communities (most of which are still in existence) were founded in Africa (Algeria, Libya, Morocco, Tunisia, Ethiopia, SE Africa), Asia (the Levant, Asia Minor, Yemen, Baghdad, Iran, India, Burma), Europe (Spain, Italy, Central Europe), and possibly other places. Some of these are more ancient (e.g. Yemen) than others (e.g. the Ashkenazi). Some were also founded by fewer people (e.g. Ethiopia). But all of them claim descent from the Jews of ancient Israel. Some of these groups grew large, but others remained quite small, causing significant levels of inbreeding over time. For example, the NW African colonies may have been settled along Phoenician trade routes. They managed to hold on during many centuries of conflict, but never managed to grow very large. Thus, high rates of endogamy exist in those small pockets. They did receive an influx of Sephardic Jews after Ferdinand and Isabella expelled the Jews from Spain in 1492, but even today one can see evidence for the two different groups in the genomes of those people.[1]

Modern genetics has advanced considerably over the past decade. With data from hundreds of thousands of individuals now available in public databases, we can draw historical inferences that would have been impossible just a short time ago. And statistical tools have been developed to take account of the overwhelming amount of data coming out of our sequencing machines. These tools allow us to see historical events in unprecedented detail. To that end, it is now possible to trace the ancestry of different sections of an individual's genome. There are some geographic areas where discriminating between two countries is difficult due to high levels of historical connectivity (France vs Germany, for example), but there are other locations where ancestry is obvious due to the presence of unique and informative groups of genetic variants (among people living in specific valleys in the Swiss Alps, for example) and continental-scale ancestry is easy to determine across most of the genome.

Thus, it should be possible to determine the ancestral source populations(s) of modern Jews. This has nothing to do with evolution, and the deep-time assumption at the base of all evolutionary storytelling does not generally apply. Ancestry is a statistical question: how much and what parts of a person's genome can be localized geographically, based on what we know about the distribution of his or her genetic variants in the contemporary human population? In short, it is now possible to definitively locate Y chromosomes, mitochondrial DNA lineages, and different stretches of autosomal DNA to specific geographic regions, statistically. This did not have to be true. We did not know it would be possible until after the data started to come in. But now that there are thousands of complete human genomes available, the case for *geographical* ancestry has become quite strong.

Multiple questions arise when considering the Jewish people. Are there 'Jewish' genes? Are the Jews a genetically distinct population? Can one trace the dispersed Jewish people back to their homeland in Israel? Is there any evidence that the 12 tribes of Israel came from a single family, with a single patriarch? Questions like these are fascinating, and can

now be answered, but with multiple caveats. To get at these answers, we must first ask what we should expect to find based on biblical history.[2] We must then look at the genetic data and assess post-biblical history, which might include confounding factors like multiple outbreeding events with non-Jewish people, high levels of local endogamy leading to strong genetic drift, and founder effects. Even though the picture is complex, we would hope that these multiple sources of information will tell us the same thing.

Y chromosomes

A direct paternal lineage from the patriarch Jacob is generally thought to define Jewishness. Yet, early analyses with limited data concluded that more than one Y chromosome haplogroup exists among modern Jews. Does this contradict the biblical narrative? Actually, no. When comparing the Y chromosome haplotypes found in Jewish and non-Jewish Middle Easterners, it is clear that they share a common pool of sequences.[3–5] The two together are distinct from non-Jewish groups in Europe, North Africa, and South Africa.[3] But the majority of *non-Middle Eastern* Jews also trace back to a Middle Eastern Y chromosome source, meaning all three groups (Middle Eastern Jews, Middle Eastern non-Jews, and European Jews) come from the same paternal stock. Hammer *et al*. (2000) conclude that a major portion of the diversity of Jewish Y chromosomes:

> "... traces to a common Middle Eastern source population several thousand years ago. The implication is that *this source population included a large number of distinct paternal and maternal lineages,* reflecting genetic variation established in the Middle East at that time. In turn, this source diversity has been maintained within Jewish communities, despite numerous migrations during the Diaspora and long-term residence as isolated subpopulations in numerous geographic locations outside of the Middle East [emphasis added]."[3]

The multiplicity of distinct ancestral paternal lineages is due to the extensive mixing between Jews and non-Jews throughout their history[2] plus the possibility of founder effects at different places in Jewish history. In other words, it is possible that a 'non-Jewish' Y chromosome is found at higher-than-expected frequencies in specific Jewish populations

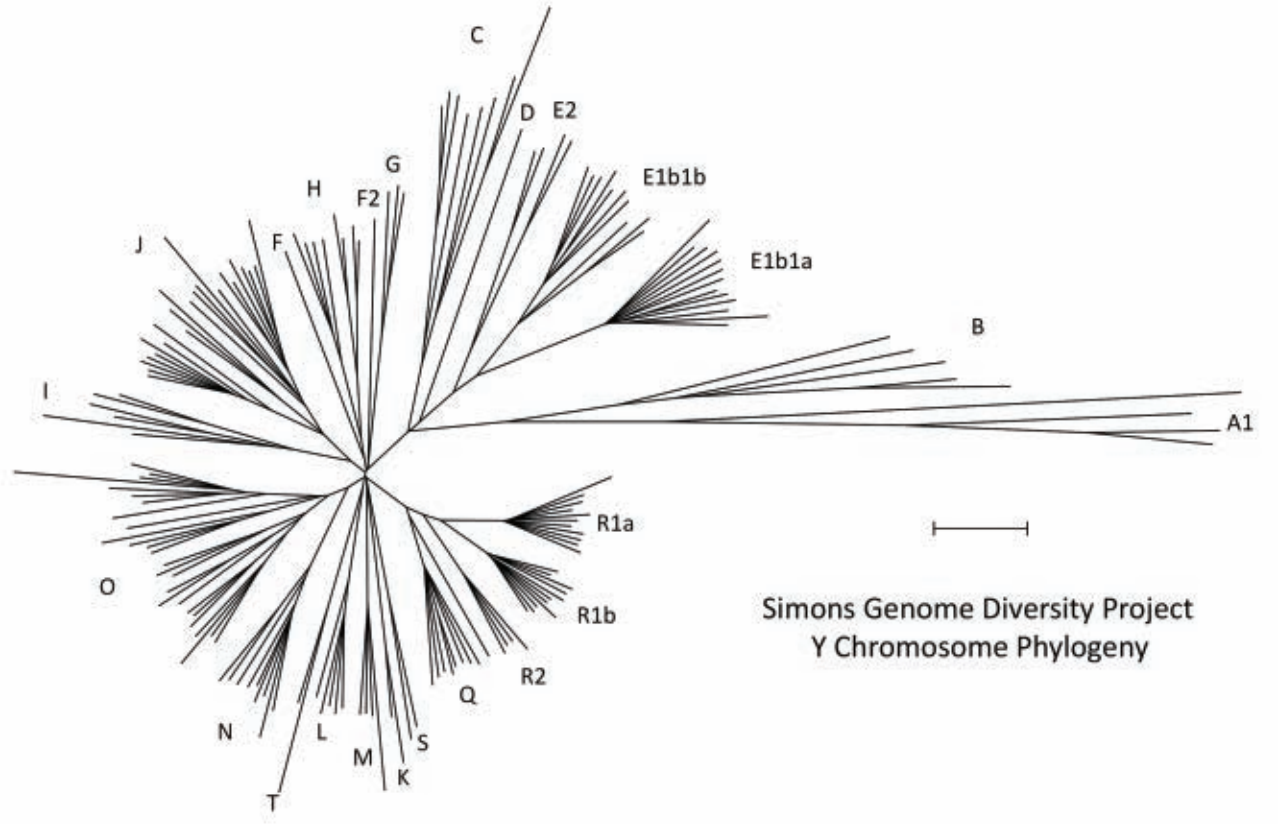

Figure 1. An unrooted neighbour-joining phylogenetic tree I created from the Y chromosome data in the Simons Genome Diversity Project.[8] The majority of Jewish men belong to haplogroup J (there is no intended association between the 'J' and 'Jewish'), but Jewish men also belong to many different haplogroups, including R, E, and others. Tree drawn using MEGA 7.0.[9] The scale bar represents approximately 700 mutations.

today simply because it happened to be represented in one of the men who founded a small colony.

Among the Sephardic Jews, Y chromosomes from a diverse background can be found. The majority come from haplogroup J (strongly associated with Middle Eastern peoples). But others are from E1b1a and E1b1b (common in Africa and other places), R1a (up to 30% in Ashkenazi men), R1b (the most common lineage in Europe), Q (Asia), I (Europe, but rare), and G (mainly Western Asia).[6] The distribution of haplogroups found among the Spanish Sephardim was similar to a Jewish population in Turkey (sometimes included within the term 'Sephardim'). This pattern also held for Jewish men from NE Portugal. Nearly one third of the Y chromosomes were European (R1b, common in Eastern Europe), and over one half were 'Middle Eastern' (37% J and 16% T).[7] Note that the 'Middle Eastern' chromosomes come from diverse lineages. Thus, all Jewish men do not all trace back to 'Jacob/Israel' and which lineage might represent him is a matter of debate. See figure 1 for an explanation of these groups and how they are related to one another. There is some debate among biblical creationists as to where the 'root' of the tree should be placed, but all of the people with whom I have discussed the subject, to date, agree that 'Y chromosome Noah' should be somewhere near the center of the starburst pattern. The evolutionary root would be located about halfway along the A1 branch. But root placement has nothing to do with the relative relationships among the groups.

The claims above were made on limited data (e.g. the studies often used only a few tandem repeats that have a high rate of back-mutation), not fully sequenced chromosomes.[10] This type of data is only useful for analyzing recent events. Re-examining such data caused Tofanelli *et al.* (2014) to conclude that, while one might be able to draw conclusions about the founding of various Jewish groups, the fact that multiple diverse lineages exist in these populations and that these lineages exist in non-Jewish groups as well "highlights the lack of support for using them either as markers of Jewish ancestry or Biblical tales".[11]

Yet, these comments were premature. Further analysis of fully sequenced Y chromosomes indicates that the Ashkenazi individuals who carry the 'European' Y chromosomes of haplogroup R are not, in fact, related to the European branches in the Y chromosome family tree.[12] Even though this family might be common in Europe, the Jewish versions were found to branch off earlier and to be more closely related to Middle Eastern men who carry haplogroup R. The clear implication is that this is an old, pre-Diaspora, possibly non-Jacob-descent Y chromosome family which is now found within the greater Jewish population. The majority of lines really do go back to a Middle Eastern setting. But would we expect them to go back to a single person? In fact, no. We would not, based on the known history of the nation of Israel.[2]

Aaron's Y Chromosome?

A surprising percentage of men across Judaism who claim to belong to the Levitical priesthood (the *Cohanim*) share a common Y chromosome within a subgroup of haplogroup J.[13] This is despite the fact that they have been separated in some cases for approximately 2,500 years. This Y chromosome type has been named the Cohen Modal Haplotype (CMH), and men who carry it are more closely related to each other than they are to the other Jews in the communities in which they live. The CMH is rare in non-Levitical Jews, is found in 50% of Levites, and occurs in a much higher proportion of the Cohanim.[14] Hammer *et al*. (2009) discovered that the Cohanim carry many different Y chromosome types, but most are at low frequencies (figure 2).[15]

This leads us to a fascinating anecdote that combines history, genetics, and oral traditions. The Lemba are a tribe from SE Africa with distinct customs and language. Their oral tradition claims they are Jewish, descendants of men involved in long-distance trade. But they are Bantu speakers and are surrounded by Bantu-speaking peoples. Analysis of their Y chromosomes revealed that more than half are of Middle Eastern origin.[16] Mitochondrial DNA, however,

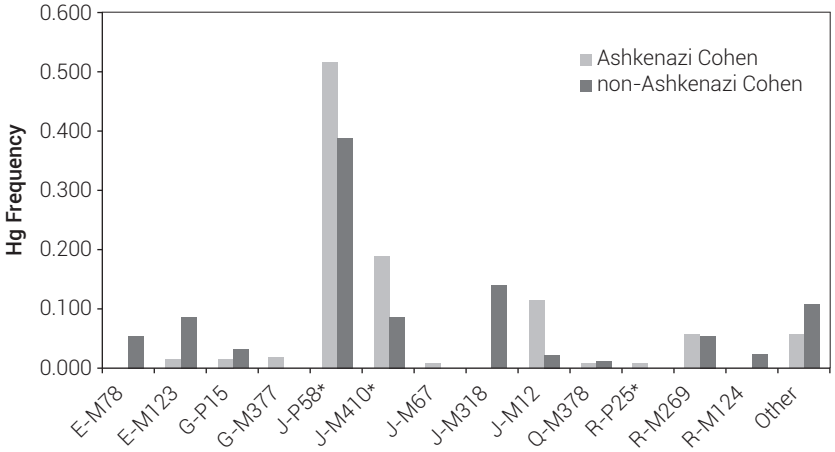

Figure 2. The frequencies of various Y chromosome haplogroups among the Ashkenazi, Cohanim vs non-Cohanim. The number and letter combination after the main haplotype designation (e.g. '-P58*') references the name of a characteristic mutation that helps to define that lineage. These naming conventions have changed much over the years. (From Hammer *et al.*[15]).

reveals no evidence of West Asian roots. This is consistent with the tradition that they were descended from Jewish traders coming down the coast from the north. But the history is further confirmed by the fact that the CMH is found within a certain subset of the Lemba.[17] So not only did a group of Jewish men become marooned in southernmost Africa, and not only did they marry local women and settle down thousands of miles south of the equator and thousands of miles more from their ancestral homeland, but it appears that a descendent of Aaron was among them.

Yet the CMH has been disputed of late. Specifically, since it is also found in non-Jewish populations, some argue that the occurrence of the CMH is nothing more than a statistical anomaly. Of course, having Jewish Y chromosomes spread far and wide is expected based on biblical history. But the original studies were also performed on only a few Y chromosome markers. When the number of markers was increased, it was learned that the Cohanim carry multiple unrelated Y chromosome types, several of which predominate.[15] Due to the random nature of paternity in small populations, it is possible that the original was lost or that an introgression occurred, and a subsequent random fluctuation brought a new lineage to the fore.

This may have been the case among the living Samaritans of Israel. Their genealogy is restricted to four main families, but the Cohen family that claims the Samaritan priesthood carries haplotype E. In contrast, the other main Samaritan Y chromosomes belonged to haplogroup J.[18] Since it is conceivably possible that something similar could have occurred among the Jews at some point in history, it is not possible to definitively state that the CMH is Aaron's Y chromosome. However, it is still likely, especially when one considers the fact that the men who carry it trace their tradition of being among the Cohanim to a time prior to the Diaspora, which began before 500 BC.

Mitochondrial DNA

Among European Jews, Y chromosomes and mtDNA yield different patterns. More than one half of the mtDNA of Ashkenazi Jews can be traced back to three unrelated women from the same haplogroup K (figure 3).[19] This represents a major population expansion and a significant founder event. These mitochondrial lines are almost non-existent in non-Jewish populations. But note that nearly half of the mitochondrial lineages do *not* belong to one of these three matriarchs. Just under one half belong to haplogroup H, which is more associated with Europeans.[20]

More detailed analyses, however, showed that the common H and K lineages (~40% of the Ashkenazim) as well as most of the minor lineages cluster deeply among non-Jewish Europeans.[22] This would seem to indicate a significant

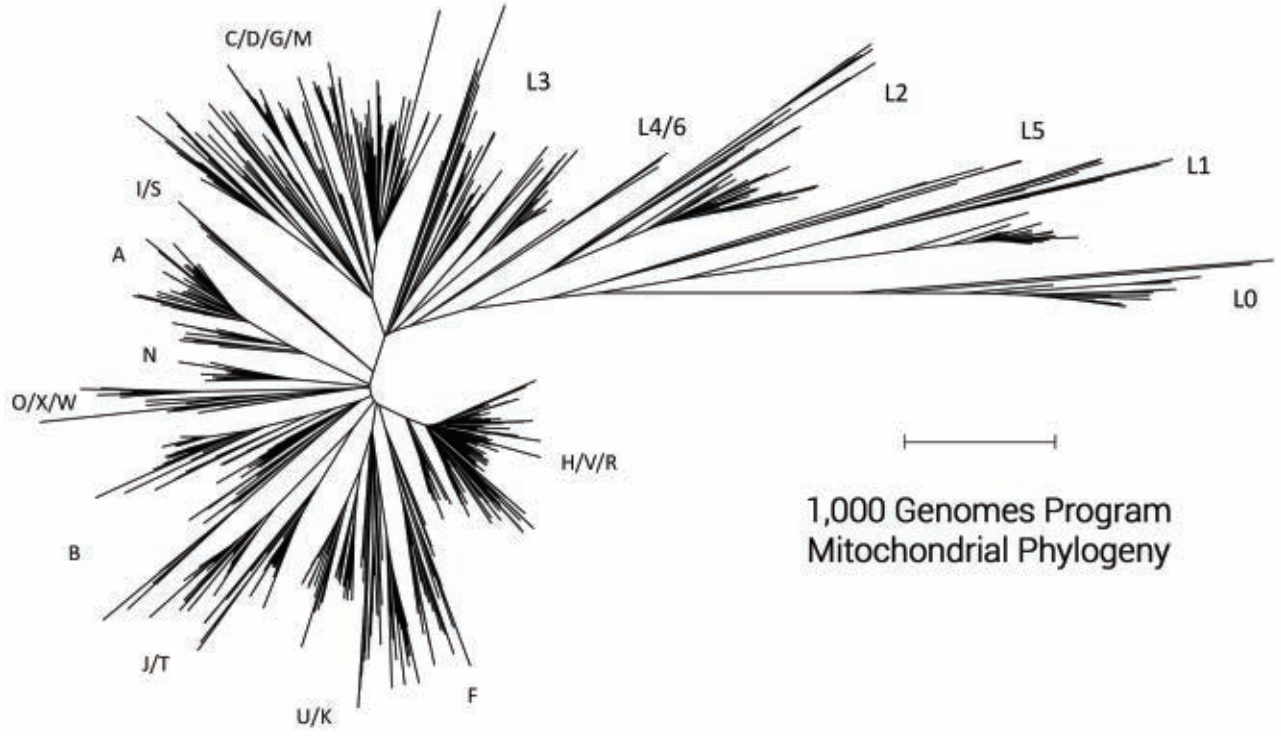

Figure 3. An unrooted neighbour-joining phylogenetic tree created from the mitochondrial chromosome data in the 1,000 Genomes Project.[21] Common mitochondrial lineages found among modern Jewish females include haplogroups K and H. The scale bar represents approximately 14 mutations.

number of the founding women among the Ashkenazi were converts. However, this does not support the contested hypothesis that the Ashkenazi came from a mass conversion of people in the Khazar Empire of the Asian steppes (see below), for the common mitochondrial lineages cluster with European lineages, to the exclusion of the others.

Multiple Jewish populations seem to stem from independent founder events with a limited number of female lineages that have not increased much in diversity since their founding. In those same communities, Y chromosomes show much more diversity.[13] This is counter-intuitive on some levels because one might expect outsider females to be over-represented in the ancestral Jewish population over outsider males. Yet, on the one hand, this might explain why so many Jewish mitochondrial sequences trace back to European founders. On the other hand, it clearly shows that paternal ancestry has been important to the Jewish people for thousands of years, as the Bible indicates, despite the fact that 'Jewishness' has been traced through the mother since the 2nd century.

Genome-wide comparisons

More detailed data sets have confirmed the conclusions of earlier studies, showing us that there exists among modern Jews a core set of genes and haplogroups that trace directly back to the Middle East. Also, significant sections of IBD (identity by descent) and other measures indicate that the various Jewish populations are more closely related to each other than they are to outsiders, despite the fact that some of these groups have been separated from one another for millennia.[23–25]

When comparing the various Jewish groups to one another and to non-Jewish outgroups, interesting patterns emerge. For instance, since they started from a small group of Jewish settlers and interbred extensively with non-Jewish outsiders, the Ethiopian Jews unsurprisingly cluster with Ethiopians in genetic comparisons. But they cluster with the Semitic-speaking Ethiopians, not Cushitic-speaking Ethiopians. The Jews of Yemen, another old and isolated population, are more closely related to Bedouins and Saudis than they are to the Yemenis. Indian Jews, like Ethiopian Jews, are closely related to their host population, indicating significant mixing over the years.[24]

But mixing can also be detected on larger scales. The following is based on evolutionary rates and dates, but it is an interesting conceptual framework that can help us to understand large-scale historic processes. The average southern European has 1–3% African ancestry, most of which probably traces back to the Arab migrations after the fall of the Roman Empire. People from the regions surrounding Israel carry 4–15% African ancestry, but these links probably trace back to more recent times (maybe 1,000 years ago). Multiple Jewish subpopulations also carry African DNA (3–5%), with an estimated mixing date of 70 generations ago. This is much older mixing than the other groups, going back more than 2,000 years. This means the African ancestry was almost certainly among them prior to the Diaspora.[26] Yet even this is much later than the biblical date for the founding of Israel (it is only about halfway to Abraham). Genetic evidence being what it is, all we can say is that the Jews in late Old Testament times already had a small proportion of African ancestry. This may not turn up in Y chromosome or mitochondrial studies due to genetic drift (where rare lineages tend to be lost) and founder events, but it has carried over to the rest of the genome.

Disease

Due to high levels of inbreeding in their close-knit communities, Jewish groups carry a surprising number of otherwise rare, recessive genetic diseases. For example, a major variant of the Creutzfeldt–Jakob disease has been associated with an origin in Spain and subsequent spreading caused by the 1492 expulsion of the Jews from Spain.[27] Bloom Syndrome is another rare, autosomal, recessive disorder most common in Ashkenazi Jews. But it is also found among Spanish-speaking individuals in Central America. Most likely, the individuals living in the Americas that are carriers had a Sephardic Jewish ancestor from Spain (confirmed by ancestry in several families).[28] Disease studies are fascinating in their own right, but since there are specific genetic anomalies associated with Jewish populations, this tells us that outbreeding with non-Jews was always limited.

Alternative theories

The Khazar hypothesis

Once Need *et al*. discovered that one can statistically separate people with Jewish ancestry from a general population of Europeans,[29] the race to discover 'Jewish genes' was on. Even though there are clear patterns, the idea that there are exclusive Jewish genes was recently contradicted by Elhaik.[30] He makes six major points, all of which are questionable. I will restate them here:

1. It is unlikely that an 'Israelite gene' ever existed since Iron Age Israelite tribes exchanged genes with their neighbouring tribes.
2. Had there been a paternal 'Israelite gene' on the Y chromosome, it would have been lost due to the transition to matrilineal descent.
3. Had there been a maternal 'Israelite gene' on the mitochondrial chromosome, it would have been lost due to the initial period of patrilineal descent.

4. Had there been an autosomal 'Israelite gene', it would have been lost due to the high rates of movements into the religion.
5. Had there been an autosomal 'Israelite gene', it would not be unique to Jews due to the high rates of movements out of the religion.
6. Had there been an autosomal 'Israelite gene' that survived to modern days, it would have been extremely rare and undetectable by popular search approaches that prioritize findings common to a large fraction of Jews.

Points 1–4 depend on the degree of mixing with other populations, plus chance. Being that the Jews have always had a certain degree of separation from other cultures, the assumption should be that they may have maintained some genetic distinction. Point 5 is a given and is well attested to in the literature. This is one of the main reasons why there are no 'Jewish' genes. But this still does not mean there are no genetic Jews. We may not be able to positively identify a Jew by their genes, but when one does find genes common to Jews found throughout their current distribution, this is a strong case for the antiquity of Judaism. His final point 6 depends on the status of his Khazar hypothesis.

Elhaik has attempted to claim Eastern European Jews were descended from the Turkic Khazars of central West Asia.[31,32] This seems to be a resurrection of the controversial ideas of Koestler.[33] But this theory was quickly shot down by others. Specifically, it seems that his team's use of the Georgian Jews as a proxy for the assumed genotype of someone from the now-vanished kingdom of Khazar was a mistake, for the Georgians are not only south of the Caucasus, but they cluster tightly with the Middle Eastern Jews in genetic analyses. Instead of being evidence for a mass conversion of Jews in ancient times, the data instead shows that the Ashkenazi Jews are related to those in the Middle East.[34]

Elhaik's team has also attempted to claim that Yiddish did not originate in Germany but NE Turkey, along the Silk Road.[35] This was also controversial, and both the methods and conclusions were soon strongly contradicted in print.[36]

I will leave it up to the interested reader to follow this up in more detail. There is some tit-for-tat going on in the literature,[37] but my personal view is that Elhaik is wrong. I do happen to agree with one of his conclusions, that Jewishness is more of a religious and/or social construct than it is a biological reality, but I come to these opinions through very different means and I reject nearly all of his criteria. Plus, I cannot discount the multiple strands of genetic and historical evidence linking them to the biblical Jews. Ashkenazi and Sephardic populations have less than 40% European ancestry, and are more similar to each other than they are to Europeans in general. So even though there has been a significant amount of interbreeding among Jews and Europeans, the Khazar hypothesis is incorrect.

The lost tribes of Israel

Essentially, there is zero attestation to the claims the Book of Mormon makes regarding Native American ancestry. Instead of descending from the lost tribes of Israel (which were never lost, cf. Luke 2:36; Acts 26:7; Romans 11:1; Hebrews 7:5; James 1:1), the genetic evidence puts Native Americans squarely into a NE Asian genetic landscape.[38] The minor contributions from Judaism we find in the Spanish-speaking populations of South and Central America clearly come from the cryptic Sephardim of Spain and Portugal. Another alternative theory is the claim that the British population descends from the lost tribes of Israel.[39] Genetically, this is 100% false. Likewise, the idea that the Picts of ancient Scotland descend from a Jewish group is false. I won't take more time on these subjects. See Sarfati (1999)[38] for more information.

Conclusions

There is no 'Jewish gene', although there are certainly genes common to Jews. And because of the possibility of genetic drift, we cannot be 100% certain that things like the CMH are actually the Y chromosome of Aaron. However, Jews today absolutely fit both the biblical expectations and their oral and written history since the completion of the Old Testament canon. From the detailed history of the Jewish nation preserved in the biblical narrative, it should be clear that they started as a mixed population, maintained a degree of mixing with their neighbours, and continue to mix with outsiders today.[2] However, as a Middle Eastern tribal community, they should have Middle Eastern genetic roots, and the evidence tells us they certainly do.

What does this tell us about races in general? Slatkin and Racimo (2016) say it this way:

> "We now know that present-day populations were created by a complex history of admixture and population movement. Although local genetic continuity over long periods has been documented in a few cases, these are exceptional. The general rule is that the ancestors of present-day populations lived somewhere else."[40]

So now we know that human history is complex and sometimes convoluted. The various people groups on this planet all have the tell-tale signs that their ancestors mixed with other people. The Jewish people, due to their rich historical background, serve as a test case that informs us what we should expect to find in other groups. Essentially every people group should represent a history of mixing that unites us all under one common banner: descendants of Adam and relatives of Jesus Christ, the Kinsman-Redeemer (Isaiah 59:20).

Acknowledgements

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Researchers remain divided over 'feathered dinosaurs'

Brian Thomas and Jonathan Sarfati

Feathered dinosaur candidate fossils have drawn huge interest from secularists who have fitted them into a dinosaur-to-bird evolutionary narrative. The same fossils draw interest from biblical creationists who strive to accurately categorize them into Genesis kinds. Some researchers, including creation paleontologists, accept feathered dinosaurs partly on the basis of detailed secular descriptions. Conversely, some creation scientists with expertise in other disciplines remain unconvinced that those secular descriptions have eliminated enough evolutionary bias to legitimize feathered dinosaurs as a Genesis-friendly category. In addition, secular reports fit the feathered dinosaur candidates into conflicting categories, and include disputes about whether certain fossilized structural remnants really represent feathers. Other intractable barriers against evolution from dinosaur to bird, including centres of mass and respiratory systems, should call into question attempts to conflate the categories. Thus, both creation and anti-creation researchers remain divided over how to categorize feathered dinosaur candidates, and even over the legitimacy of 'feathered dinosaurs' as a category.

While a large majority of secular scientists agree that some dinosaurs had feathers, creation scientists remain divided. The very concept of feathered dinosaurs arose only a few decades ago, when new fossils from China began to reveal fossilized fibres and later actual feathers still associated with some dinosaur-like fossils, plus fossilized fibres interpreted as protofeathers on other fossils. New discoveries of hard-to-classify extinct and feathered or fibred fossil forms have prompted some creation researchers to admonish their peers to embrace feathered dinosaurs. The various arguments that each side advocates reveal a healthy ongoing scientific and biblical exchange.

Not game-changing, but important (and fascinating)

Biblical creationists have long noted that Genesis 1 does not specify whether or not God created Day 6 land creatures including dinosaurs with or without feathers.[1] So what's the big deal?

Genesis 1:21 says: "So God created great sea creatures and every living thing that moves, with which the waters abounded, according to their kind, and every winged bird according to its kind. And God saw that it was good." Either God was correct when He asserted that "every winged *ôph* [flying creature, including birds, bats, pterosaurs, and insects]" reproduced "*according to* their kind", or today's secular scientists are correct when they assert the Genesis antithesis: that each winged flying creature evolved by morphing *between* fundamental kinds.

A genuine dinosaur (reptile kind) with *bona-fide* feathers that today characterize various bird kinds might not directly affront Scripture's within-kind demand, but it would fuel evolutionary bias by blurring between-kind lines. "We have clearly defined, anatomy-based categories for 'bird' and 'dinosaur,' but evolution needs a third, bird-dinosaur transition category."[2] Since secularists could more easily construe a feathered dinosaur to fit that third category, biblical scientists should show healthy caution in interpreting feathered dinosaur claims.

Some feathered dinosaur advocates use arguments from authority, which we consider weaker because they point to expert opinions instead of evidential analyses. Expert opinions have value especially for the expert who can pinpoint and explain fact-based supporting evidence to back their conclusions, but we find a lack of backing in some of the arguments put forth. The weakest of two arguments from authority that we have encountered in friendly verbal discussions asserts that creation researchers should trust evolutionary scientists' labels of 'feathered dinosaurs' because the evolutionists have first-hand and thus the most intimate knowledge of the fossils. But does this argument overlook the role of bias in evolutionary assessments? Despite close fossil interaction, secularists can succumb to the temptation to "willfully forget" evidence for creation and the Flood, as per 2 Peter 3:5, as well as to "suppress the truth" that aligns with biblical creation as per Romans 1:18.

Archaeopteryx and authority

This anti-creation bias probably surfaces when evolutionary paleontologists recategorize fossils. Even among evolutionists, one's assessment could depend on whether one believes that birds evolved from dinosaurs or from non-dinosaurian reptiles. For example, Chinese

workers Xu, You, and Han used a cladistics analysis to determine that *Archaeopteryx*, long considered a bird, better fit within the dinosauria.[3] Just a few months later, Australians Lee and Worthy performed a similar analysis, but emphasized different traits with different weights to find that *Archaeopteryx* groups with Aves after all:

> "The reinstatement of *Archaeopteryx* as a basal bird in both likelihood-based analyses contradicts macroevolutionary inferences that relied (at least partly) on the shift of *Archaeopteryx* into deinonychosaurs."[4]

Archaeopteryx certainly has a number of unambiguous bird features, as evolutionists and creationists have pointed out:

- Perching foot.[5] This means that its wings would have needed to be sophisticated enough to produce the special wing turbulences (leading edge vortices) like those of modern birds, so that it could land delicately on a branch.[6]
- Classical elliptical wings like modern woodland birds.[5]
- Fully-formed flying feathers (including asymmetric vanes and ventral, reinforcing furrows as in modern flying birds).[5]
- A large furcula (wishbone) for attachment of strong muscles responsible for the downstroke of the wings. Figure 1 shows the flight-ready *Archaeopteryx* furculum, as reconstructed from fossil comparisons.

Similarly, *Scansoriopteryx* (*Epidendrosaurus*) received happy initiation into the feathered dinosaur category only for a later analysis to settle its identity as 'a non-dinosaurian bird'.[7,8] Which authority should a non-expert trust and why?

A call for clarity on *Caudipteryx*

Caudipteryx is another favourite 'feathered dinosaur' that exemplifies a need for evidence to undergird an authoritative statement. General consensus among uniformitarians holds *Caudipteryx* as a basal form of the clade Oviraptorosauria—a word basically defined as 'feathered dinosaur'. However, a number of evolutionists have argued that it was an extinct bird that had lost its ability to fly, somewhat like today's flightless cormorants. For example, some eminent Polish dinosaur experts argue that birds did not evolve from oviraptorosaurs, but from earlier theropods. One lineage supposedly lost the power of flight to become evolutionary dead-end oviraptorosaurs. Some of their bird-like features include:

> "… extensive pneumatization; enlargement of the parietal portion of the skull roof; double-headed otic process of the quadrate; lateral cotyla on the quadrate for articulation with the quadratojugal; functional loss of contact between the palate and jugal; shallow or rod-like jugal. This set of traits is absent in non-avialan theropods but is present in advanced birds."[9]

We quote this not necessarily to prove that *Caudipteryx* was a bird, but to demonstrate the insufficiency of appealing, either directly or indirectly, to evolutionary expert analysis, since those analyses conflict over each supposed feathered dinosaur.

In other words, certain evolutionists have interpreted these extinct creatures as intermediates that support the evolution of non-flying dinosaurs into flying birds, but others as representing devolution *from* flying birds. While creation researchers disagree over whether or not one should call *Caudipteryx* a bird or dinosaur, we all agree that the 'grandfather paradox'—summarized in Alan Feduccia's quip that you can't be older than your grandfather—erases its evolutionary status. Granting evolutionary dating for the sake of argument, *Archaeopteryx* is allegedly 153 Ma,[10] and the beaked bird *Confuciusornis* is 'dated' to 135 Ma, but their alleged feathered dinosaur ancestors such as *Sinosauropteryx* and *Caudipteryx* are considered younger than their supposed descendants, 'dated' to ~125 Ma.

The definition of dinosaur needed to expand to include odd fossil bird-like forms like *Caudipteryx*. But why force definitions to evolve when not all evolutionists agree that birds evolved from creatures like these? Some evolutionists call this an odd bird with no dinosaur relation at all. Flip-flopping between huge category distinctions reveals root problems in interpretation. More complete data sets would help, as would the reduction of bias. An investigator can select or overemphasize traits that fit evolutionary or creationary narratives. After all, evolution's advocates would love to find feathered dinosaurs. Why should creation scientists uncritically swallow what evolution-believing experts say when they're saying different things?

What about bias?

The argument that biblical creationists should accept uniformitarian assertions of feathered dinosaurs suffers from a lack of control against evolutionary bias. A second argument from authority asserts that creation science skeptics of feathered dinosaurs do not have expertise in paleontology, whereas creation science believers in feathered dinosaurs do. Thus, the former should defer to the experts. But again, an expert should be able to supply factual backup when needed. The creation paleontologist who backs a feathered dinosaur category merely by referencing secular assessments ought first to explain why evolutionary bias played no role in those studies. They should also show why their expertise trumps that of evolutionary *paleornithologist* feathered dinosaur doubters like Alan Feduccia, Storrs Olson, and the late Larry Martin (1943–2013). Specific anatomical reasons to accept feathered dinosaurs would be more convincing than use of *argumentum ad verecundiam*—authority-based arguments.

We propose two anatomical categories as possible anchors for discernment: feathers and femurs, and we tentatively suggest that vertebral spinous processes, lung structure, and quill knobs might also help.

The traditional means of identifying birds was feathers. No living reptile or mammal has feathers. Therefore feathers should identify a fossil as a bird unless it has overtly distinct and virtually undisputed non-avian skeletal characters. But which fossils have real feathers?

Fibres for feathers?

One of the best known 'feathered dinosaurs' is the ~1-m-long *Sinosauropteryx*, a compsognathid dinosaur discovered in 1996. Some filaments ('fuzz') were discovered which have been widely interpreted as feathers or 'protofeathers,' since the filaments do not branch whereas bird feathers do branch. However, the animal was found in the common death pose, with its neck thrown back, which probably occurred during perimortem or postmortem degradation while submerged.[11] This extreme arching back caused the dorsal integument to buckle, and this buckling could be observable most sensibly if these filaments were part of a unified structure like skin, not feathers. Evolutionist and feathered dinosaur doubter Theagarten Lingham-Soliar explains:

> "... compressive and tensile forces acting on a clearly unified structure, i.e. an upright frill or crest overlying the neck, back and tail of *Sinosauropteryx* … as opposed to individual proto-feathers, is considered more reasonable ... . The results include the most controversial issue associated with *Sinosauropteryx* and strongly demonstrate, based on soft tissue analysis and forensic animation, that the dorsal, externally preserved integumental tissue represents a dorsal crest rather than protofeathers … ."[12,13]

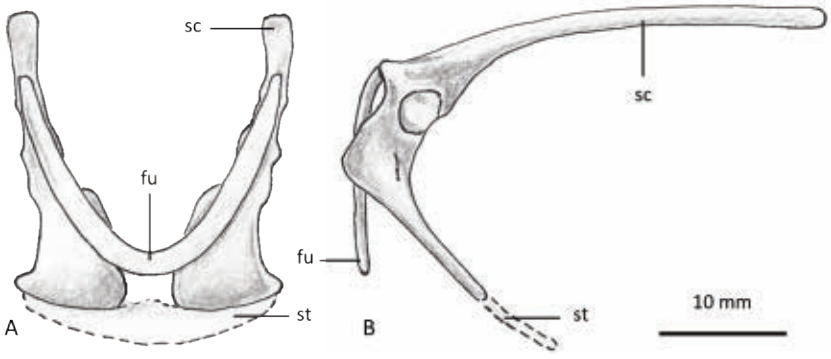

Figure 1. *Archaeopteryx pectoral* girdle, restored on the basis of different specimens. A) Front view. B) Left lateral view. Drawing after Wellnhofer, p. 128. fu: furcula; sc: scapula; st: sternum.

A buckled dorsal skin crest, like that in iguanas, partly decayed, leaving skin fibres, not feathers at all. Figure 2 shows a *Sinosauropteryx* specimen with a darkened halo, also found surrounding many clearly identifiable forms like mosasaurs that may represent organic remnants. The halo dorsal to the spine in this specimen conforms to the Lingham-Soliar explanation of diagenetically altered skin frills. He co-authored a 2005 study that found a very close match between decayed skin fibres and the fossil 'protofeathers'.[14] Also, Lingham-Soliar shows that *Sinosauropteryx's* tail didn't end in a taper, but in a spatula shape with 'fuzz' around it. He suggests that since the fossil is found associated with lacustrine biota, *Sinosauropteryx* was probably semi-aquatic, and a spatulate structure would greatly aid propulsion through water:

> "Finally, it is bewildering that in a lacustrine environment, a crest-like structure on the tail or body or both, useful in swimming, is generally not even contemplated in dinosaurs such as *Psittacosaurus*, *Sinosauropteryx*, *Tianyalong*, and *Beipiaosaurus*."[12,15]

This is a huge contrast from *real* feathers, which Lingham-Soliar analyzed under an electron microscope when he discovered the "biomechanically 'ingenious' and novel architecture of the fibre organization".[16]

His 2016 study of rotting ostrich carcasses found more evidence that supposed protofeathers are actually collagen fibres from decaying skin. First, the ostrich feathers on land scattered into a tangle with no organization in under 100 hours during degradation. In water, feathers detached after just a few days of rotting, then scattered and travelled further from the carcass. Lingham-Soliar contrasts those tangled feathers with the organized fibres in the fossils. Second, after the carcass had completed its five-day rotting and become skeletonized, its skin, bones, and some connective tissue remained largely intact even after its internal organs and muscles were gone. He noted that the skin's persistence—including the ostrich scaly foot skin—matched the skin remnant interpretive scenario for 'protofeathers'. He wrote: "The presence of internal structural fibres protected by skin and scales before ultimate destruction is the parsimonious explanation."[17] Further, he noted that the most pronounced 'opisthotonous' posture occurred under water, "strongly supporting the post-mortem hypothesis of the phenomena".[17] These fibres of possible skin remnants thus seem utterly insufficient to classify *Sinosauropteryx* as a bird rather than a dinosaur.

A 2017 report from senior author Jakob Vinther has disputed some of Lingham-Soliar's work on *Sinosauropteryx*.[18] It uses higher resolution photography to demonstrate that some 'collagen' fibers were actually preparation marks made by air scribes, and others were were actually tiny, linear features of the sedimentary matrix. However, three *Sinosauropteryx* specimens do have very dark fibrous remnants. These may or may not represent collagen, but nor do they likely represent feathers, since feathers are branched and these fibers are not. Without real feathers, the animal would not fit a feathered dinosaur category.

The 2012 description of an estimated one-tonne Chinese tyrannosaurid with 'feathers' fits a similar description.[19] It had non-branching fibres only. They could represent frayed collagen fibres from partially decayed skin. If they were non-branching feathers, as the authors asserted, then they would be unprecedented biological structures, they would be unprecedented in reptiles, and they would have been purely aesthetic since the animal and its fibres were utterly unsuited for flight. Why insist on a feather interpretation when it carries this kind of baggage and when the simpler, albeit less exciting, decayed skin interpretation fits the data just fine?

In contrast, some supposed feathered dinosaurs like *Microraptor* had asymmetrical feathers and gross anatomies outfitted for flight or at least for gliding. What clear non-avian skeletal structures demand a reptilian as opposed to the avian classification for *Microraptor* that its feathers indicate?

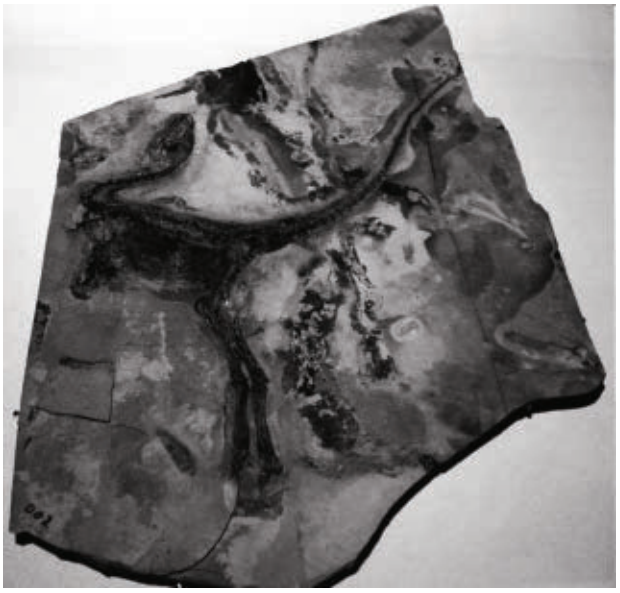

Figure 2. *Sinosauropteryx prima*, an Asian compsognathid, displayed at the Hong Kong Science Museum. Specimen shows darkened halo adjacent to body, especially dorsal to the spine. In some specimens, the halo extends over body parts including forelimbs and cheeks and consists of defined fibres interpreted either as protofeathers or diagenetically reduced skin remnants. Image: Laikayiu, *Wikipedia*.

Limb structure and centre of mass

Flying birds have a distinct anatomy for flight, which their very powerful front limbs power. So a flying bird's centre of mass lies quite close to the wings, in contrast to a theropod where the centre of mass rests over its hips. An evolutionary transition would have needed to shift the mass forward for flight. Feduccia argued long ago:

> "'It's biophysically impossible to evolve flight from such large bipeds with foreshortened forelimbs and heavy, balancing tails,' exactly the wrong anatomy for flight."[20]

If the supposed mass shift happened before the wings fully formed, then the resulting dinosaur would obviously not yet fly, but couldn't run either. It would fall on its face figuratively and literally. Similarly, flight or even gliding wings like those on *Archaeopteryx* would get in the way of theropod locomotion enough to label their possessor less fit, ending its line of descent long before it could reach a flying bird stage.

Femur orientation dovetails with body balance, and should help adjudicate between bird and dinosaur. Avian femurs are housed within their bodies, integrate with and stabilize their air sac networks, and move very little. "What seems like its 'knee' is equivalent to our ankle",[1] whereas dinosaur legs hinge at the hip. This is important for their breathing:

> "The thin walled and voluminous abdominal air-sacs are supported laterally and caudally to prevent inward (paradoxical) collapse during generation of negative (inhalatory) pressure: the synsacrum, posteriorly directed, laterally open pubes and specialized femoral-thigh complex provide requisite support and largely prevent inhalatory collapse."[21–23]

Ground-dwelling birds like cassowaries and roadrunners resemble the candidate feathered dinosaurs more closely than powerful flying birds do. Even these ground-bound birds use the fixed-thigh structure of strong flying birds. Preliminary reconstructions of *Microraptor* skeletons seem to show that if its thigh pointed down like dinosaurs (i.e. its legs hinged at the hips and not the knees), then its centre of gravity would have been too far forward. It would have fallen on its face. But by orienting its femurs forward to maintain anteroposterior balance, its centre of gravity would have hinged over its 'knee', as in birds. Creationary advocates of feathered dinosaurs might more easily persuade peers if they could construct digital or physical models of the fossils in question to test where the centre of gravity lies over the wings (i.e. bird) versus hips (i.e. theropod) femur orientation.

Caudal spinous processes

In addition to limb structure and centre of mass, a third key avian structure that might serve as an objective adjudicator between dinosaur and bird is the height of spinous processes on tail vertebrae. Theropods had tall spinous processes used for muscle attachments, resulting in powerful and finely controlled tail movements. But flying birds generally have few or no spinous processes on their caudal vertebrae. Therefore, somewhere along the supposed evolutionary line, theropods dropped the spinous processes. Those dramatic reductions in muscle attachments and in mass surely reduced control of the tail. Wouldn't its fully tailed cousins outcompete it on tight turns while chasing food? This means that natural selection would tend to keep the heavy tail musculature instead of moving the centre of mass forward for flight.

Admittedly, spinous processes may not help classify all the feathered dinosaur candidates, since some extinct ground-based birds may have had somewhat prominent ones. But could they at least help identify *flying* birds in the fossil record? For example, *Microraptor*'s long, bony tail vertebrae had no spinous processes, consistent with a flying, not a primarily running anatomy. It did have feathers connected to its hind legs. It had bird feathers, possibly bird fixed thighs, and non-theropod caudal vertebrae. So why not classify it as a four-winged, extinct, feathered, running/gliding bird?

Perforate acetabula

Probably the most definitive anatomical characteristic of dinosaurs is their open (or 'perforate') acetabula. The three hip bones ilium, ischium, and pubis join at the acetabulum—the socket into which the head of the femur articulates. Other tetrapods, including non-dinosaur reptiles, mammals and birds, have a closed, cup-shaped acetabulum, which derives from the Latin for 'little vinegar cup'. All (and only) dinosaurs had no bone at the back of their acetabula. Figure 3 shows two dinosaurs' open acetabula.

Thus, a definitive feathered dinosaur fossil should show preserved, branching feathers associated with a skeleton having an open acetabulum. *Archaeopteryx, Scansoriopteryx,* and *Microraptor* had partially open but largely closed acetabula[7] unlike those completely open in dinosaurs and unlike those completely closed in modern birds. In conformity to their many other bird-like features such as feathers, these at least seem better described as odd, extinct birds than as 'feathered dinosaurs'. Has anyone found a fossil with a completely open acetabulum plus feathers? If so, why not simply let that evidence cut to the chase of changing feathered dinosaur doubters' minds?

Avian lung

Birds use flow-through, one-way lungs, connected to air sacs and even to their hollow bones. This system

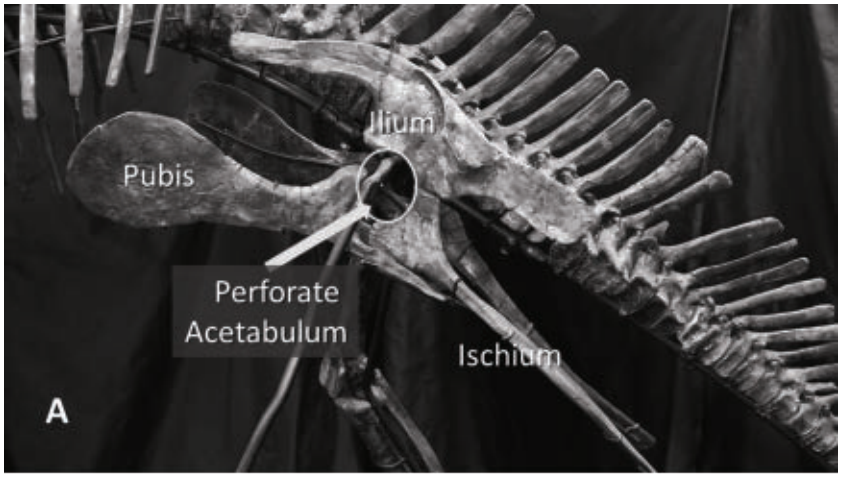

Figure 3. Perforate acetabula in dinosaurs. A) Steel armature travels through the perforate acetabulum seen in an original fossil juvenile *Edmontosaurus*. Bones of the ornithischian hip girdle are also labelled. B) Author's (BT) fingers extend through the open acetabulum in a replica fossil adult *Stegosaurus* (also order Onithischia). The acetabulum is proposed as an anatomical indicator of feathered dinosaurs. Note also the prominent caudal spinal processes for tail muscle attachments. Birds lack these processes.

keeps air flowing in one direction through gas-exchanging parabronchi in their elliptic-shaped lungs, and blood moves through the lung's blood vessels in the opposite direction for efficient oxygen uptake.[10] This excellent engineering design explains why birds don't gasp for breath after they land.[11] *Archaeopteryx* had such a system.[24]

However, reptiles, probably including *Sinosauropteryx*, have a bellows-like lung.[25] But could one type turn into another by slow-and-gradual changes if each stage must have a selective advantage over the prior one? On the contrary, the hypothetical intermediate structures would probably have lethal selective disadvantages including a diaphragmatic hernia:

> "The earliest stages in the derivation of the avian abdominal air sac system from a diaphragmatic-ventilating ancestor would have necessitated selection for a diaphragmatic hernia in taxa transitional between theropods and birds… . Such a debilitating condition would have immediately compromised the entire pulmonary ventilatory apparatus and seems unlikely to have been of any selective advantage."[25]

Despite their bellows-like lungs, some reptiles, including iguanas, monitor lizards, and alligators, have been discovered to possess a form of unidirectional airflow.[26] However, they don't need the avian system of air sacs and parabronchi; instead, the airways are shaped and angled to generate jets that produce one-way airflow,[27] an ingenious design that humans may never have imagined possible.[28]

These unique and exquisitely functional lungs come nowhere close to solving the basic problem of how to go from one structure to another with the undoubtedly lethal intermediate forms between bellows and flow-through lungs. It also raises the question of what selective forces would drive such a change. Why evolve flow-through lungs for unidirectional airflow if this can be managed by properly designed bellows lungs? And unidirectional airflow couldn't have been driven by the requirement for flight, since it supposedly arose in non-flying creatures—never mind the fact that a mere requirement for flight could never actually engineer a body fit for flight.

All creation researchers—whether they accept feathered dinosaurs or not—should agree that this hypothetical lung transition remains a huge problem for evolution. We further suggest that it adds caution to feathered dinosaur interpretations. Of course, lungs are soft tissue, so fossil interpretation is always problematic without exceptional preservation or close analysis of the difficult-to-access interior rib cage for attachment points of muscles involved with breathing. Creation-based feathered dinosaur proponents should reject an evolutionary transition between these distinct types since no data supports such a scenario, but their case for feathered dinosaurs would be strengthened by demonstrating, for example, that *Archaeopteryx* had a bellows lung after all, or that the claimed feathered dinosaurs had the avian parabronchial flow-throw system.

Quill knobs

Some researchers have granted feathered dinosaur status to fossils on the basis of quill knobs. These bone bumps occur as small, shallow tubercles along the rear ulna in birds that use powered flight. Each one anchors a ligament that attaches to the base of a large pennaceous feather. This system helps critical flight feathers resist the physical rigours of strong flight. Quill knobs in extant birds have regular sizes and maintain regular distances between one another. In contrast, the supposed quill knobs on the few feathered dinosaur candidates with forearm tubercles have more variations in size, show irregular spacing, and instead of a neat row along the rear (caudal) ulna, are oriented at different angles along the bone. This latter feature means that if the tubercles were quill knobs, their attached feathers would stick out in places unfit for wings and possibly unfit for anything.

Extant non-avian bones can have small bumps for use as attachment points for sheets of connective tissue or tendons that have nothing to do with feathers. Why must these fossil bone bumps carry quill knob status when they fail to match avian quill knobs?

Quill knobs do not occur on some gliding birds' bones today, e.g. the albatross, so the feature is not diagnostic of all birds. Some *Velociraptor* forearms had bumps interpreted as quill knobs, but most have no bumps there.[29] Features that have equivocal interpretations like fibres and tubercles always seem to receive the most evolution-friendly options. Thus, evolutionary bias may have unduly influenced interpretations of fibres as feathers and shallow tubercles as quill knobs.

Conclusion

Differences among creation researchers over 'feathered dinosaurs' should not trump agreement on larger issues. Believers in biblical creation agree, on solid anatomical grounds, that dinosaurs did not evolve into flying birds. We also agree on biblical grounds that if there were feathered dinosaurs, then God must have directly made them that way or designed them with the potential to develop that way. Disagreement arises over whether any candidate fossil *demands* feathered dinosaur status.

The current admittedly non-expert authors welcome suggestions of additional anatomical touchpoints for consideration, application of these touchpoints in evaluations of candidate feathered dinosaurs, and in short more convincing evidence than so far presented. In addition, we suggest that discussions about feathered dinosaurs avoid authority-based arguments when possible, deal with the role that evolutionary bias might play in secular cladistics

and fossil feature interpretations, and offer appropriately objective means to adjudicate between secular identifications of a particular fossil as a feathered dinosaur and secular identifications of the same particular fossil as not a feathered dinosaur.

In short, more concrete evidence such as feathers, femurs, and acetabula, or more clear explanations of that evidence, should help resolve disagreement over how to categorize certain strange and extinct birds or bird-like creatures.

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